PB-14/ 220

COMPOSTING OF ORGANIC WASTES. AN ANNOTATED BIBLIOGRAPHY. SUPPLEMENT 1

John S. Wiley

Technical Development Laboratories
Savannah, Georgia

June 1959

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COMPOSTING OF ORGANIC WASTES: AN ANNOTATED BIBLIOGRAPHY, SUPPLEMENT 1, by John S. Wiley. June 59, 66p. 141 refs.
Order from LC mi$3.90, ph$10.80 PB 147 220

See also PB 147 219

(Engineering--Sanitation, 18 Nov 60)

PB 147 220

1. Garbage--Processing
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4. Bibliography--Fertilizers
5. Bibliography--Organic wastes
I. Wiley, J. S.

Office of Technical Services

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U. S. Department of Health, Education, and Welfare
Public Health Service, Bureau of State Services
Communicable Disease Center, Technology Branch
Technical Development Laboratories
Savannah, Georgia

June, 1959

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SUPPLEMENT 1

COMPOSTING OF ORGANIC WASTES--AN ANNOTATED BIBLIOGRAPHY

John S. Wiley, Editor
Equipment Development Section

Introduction

The initial bibliography, published in February, 1958 and distributed to a select mailing list, was well received and immediately brought forward numerous additional articles, largely foreign, on the subject of composting. These and other articles brought to the editor's attention have been abstracted and are included in this supplement, which is still undoubtedly far from complete.

On February 18, 1958, a letter was addressed to the editor from Prof. Dr. O. Jaag and Dr. R. Braun, President and Secretary, respectively, of the International Research Group on Refuse Disposal (IRGR) (211) with headquarters at Zürich, Switzerland, advising of the group and requesting assistance in the English translation of their Bulletin of Information. The PHS Communicable Disease Center has distributed the first five of these bulletins, adding to its composting mailing list those names submitted by IRGR as English-speaking members. Inasmuch as these IRGR bulletins contain complete short articles and summaries or abstracts of other articles on the same subject matter as this bibliography, abstracts of about 50 articles included therein are not repeated here. However, they are listed alphabetically by senior author with the reference "see IRGR". Both the IRGR bulletins (English version) and the initial annotated bibliography may be obtained from PHS, CDC, TDL, P. O. Box 769, Savannah, Georgia.

The situation in the United States regarding composting of municipal garbage or refuse remains about the same as existed in February 1958. The CDC Phoenix Field Station has demonstrated by a small pilot plant that refuse sorting and grinding is economically advantageous, regardless of the method of disposal, particularly when the hauling distance is great (234). A cost feasibility study by the CDC Technical Development Laboratories, comparing costs of mechanical and windrow composting with sanitary landfill and incineration revealed that mechanical composting requires a high initial investment but windrow composting should compete well with the other two methods of disposal. The agricultural and horticultural value of the compost from wastes has still to be scientifically determined in the U. S., although a small field growing study is being made by Arizona State College at Tempe.

It now appears that 3- to 5-day mechanical composting or 10- to 14-day windrow composting of domestic wastes per se is inadequate to produce a sufficiently stabilized compost. More realistic times appear to be:

(1) 5- to 7-day mechanical composting with continuous mixing and positive aeration, followed by about 2 to 3 weeks of "curing" or "maturation", or

(2) 21-day windrow composting with 3 to 7 vigorous turnings, followed by about 2 to 3 weeks of "curing" or "maturation".

The next step in the U. S. appears to be the construction and operation of a sufficiently large pilot plant or full-scale plant to show both the practicability and the economics of a given composting process for waste disposal.

Errata in initial Annotated Bibliography

	Page	Abstract
"Kriege" should be "Krige"	43, 110, 111, 120	137
"Chaux-de-Fonds, France" should be "la Chaux-de-Fonds, Switzerland"	58, 122	76b
"Popel" should be "Pöpel"	69, 120	85
"Van Maahen" should be "Van Maanen"	101, 126	122
"Westrate" should be "Weststrate"	108, 119, 121	133, G10

Bibliography on Composting of Organic Wastes
Supplement 1

146. Acharya, C. N.: Preparation of compost manure from town wastes. Indian Council of Agricultural Research, Bull. No. 60 (Govt. of India Press) 22 pp 1950.

India has become more urbanized in the last 40 years. Cities and towns (pop. 2,000 and more) numbered 26,374 with 125.7 million people in 1941. They have organizations for collection of municipal refuse. Refuse amounts are 0.67 to 0.75 lb/cap/day and night soil 0.33 to 0.50 lb. India also has 250 million head of livestock, some living in cities. Indians are conservation-minded, desiring to return wastes to the soil but less than 10% of urban wastes are being so returned. Vast areas of India are of heavy clay or sandy loam soils, both in need of organic matter. Farmyard manure is the main source at present. Refuse is generally dumped in low areas while night soil is generally decomposed anaerobically in earth-covered pits or trenches. Only about 25 municipal centers are sewered and there is some sewage irrigation.

The Indian Council of Agricultural Research, Bangalore, has developed the Bangalore System which has been extensively tested by cities for composting municipal wastes. The method treats refuse, night soil, slaughter-house waste, and sullage, is sanitary, and produces good humus. Composting is done in trenches 3 to 3.5 ft deep x 5 to 8 ft wide x 15 to 30 ft long. Trenches hold not more than 2 days' supply of refuse and night soil. The area required is about 2 acres/10,000 population. Night soil and refuse amounts to about 1,000 tons/10,000 pop/yr. Refuse is placed to a depth of 6 inches in the trench and then a 2-in quantity of night soil is added. Layering is repeated. At the end of the day, a 9-in layer of refuse or a layer of refuse covered with a one-in layer of earth is provided.

In 3 to 4 days the temperature should reach 60° C and this should last 2-3 weeks. The manure is ready in 4 to 6 months, being well decomposed, odorless, and innocuous. Trenches may be filled level, or in rainy season, mounded to a height of one foot. One laborer can handle one ton each of refuse and night soil per day and the cost of the operations producing compost is about Re. 1.8/ton. Sorting is not generally done except for large article removal. The compost may be sieved later, if desired. Heavy earth cover limits aeration and prevents high temperatures.

If proportions by weight of refuse and night soil are 1:1, the moisture content at the start is about 45-50% which is satisfactory. Water may have to be added during composting in the dry season but should be stopped a month before the rainy season. Heaps above ground may be composted where the ground-water level is high or

146. trenches become waterlogged in the rainy seasons. Sullage water may be added to increase moisture under dry conditions. Other farm wastes, such as slaughter-house wastes and sewage sludge, may be composted also. Refuse sorting and crushing can reduce the composting time from 4 to 2 months, as in England. However, most conveying, grinding, and mechanical screening equipment is economical only in the larger cities of India. Cost of screening by hand is about Re. 2/ton.

Fly breeding is minimized due to high temperatures but various fly control measures are given. Tests should be run to determine: sanitary factors, temperature, moisture, and rate of decomposition as judged by color and evidence of breakdown of organics. Screening is usually done through expanded metal having 1.5 in x 0.75 in meshes. (Ed. note: There is no mention of turning or mixing of the composting matter once placed.) Some analyses giving C, N, P_2O_5, K_2O and CaO are shown for various composts and fresh wastes.

Application rates for intensive cultivation are generally 5-10 tons/acre, for wheat 3-5 tons/acre, and for dry farming about 1 ton/acre, applying every 2 or 3 years. Transportation is the main difficulty in selling compost to farmers. Some cities maintain manure sales depots 4-5 miles from town, dividing costs between city, the Government, and the purchaser. A little over 1 million tons of compost were produced in India in 1949-50, and about 850,000 tons were sold.

147. AkA (Arbeitsgemeinschaft für kommunale Abfallwirtschaft): Meeting of AkA at Düsseldorf (Summary) IRGR (3) 10-16, Oct. 1958 (1957 - German).
(see IRGR)

Four working committees (in Germany), concerned with the problem of domestic wastes, united in 1952 to form the AkA (Working Committee on the Management of Community Wastes). It has a Council and a Committee of Experts concerned with formulating the research problems and submitting programs to Federal, State, or Provincial authorities to obtain research grants. The AkA has a 3-part research program of its own: (1) Procedures for treating refuse, with and without sludge; (2) Procedures for evaluation of refuse compost by planting trials; (3) Possibilities for use of refuse composts in agriculture, horticulture, viniculture, and sylviculture.

148. Allenspach, H. Investigations on the common treatment of digested sludge and rubbish. IRGR (1) 23-24, May 1958 (1956).
(see IRGR)

149. Amer. Pub. Wks. Assn. - Pub. Health Serv.: Refuse collection and disposal for the small community. Pub. Health Serv. Joint Comm. Rept. 39pp, Nov. 1953.

149. (Only a small portion of this report is included here as it pertains to composting.)

"Although it has had much publicity during the past year, composting, as a method of refuse disposal, is not new. The improvement of soil, by returning vegetation and other organic materials to it, has been known since man began to cultivate crops for his subsistence. To restore nitrogen, cover crops such as clover and cow peas are plowed under, and in a year or less are decomposed. The value of composted refuse from households appears to lie in mechanical improvement of the soil rather than as a fertilizer, measured by chemical standards. Besides rendering the soil more porous, or friable, and improving its capillary action so as to conserve moisture, composted refuse is also known to carry small amounts of various mineral elements needed by the soil.

"The various processes which have been used in composting garbage and other household refuse on a commercial scale are directed towards speeding up the decomposition in comparison with natural conditions. From one to five weeks are required in manufacturing processes, compared to a year or more when nature is left to do the work. This method, at present, is not considered applicable to the small community. It can use, probably, not more than 40 percent of the refuse collected, and highly skilled and intelligent operation is needed to obtain best results. Besides, the problem of marketing the product is a business undertaking, for which the small community is usually not adequately staffed."

150. Amer. Soc. of Civil Engrs.: Investigation of planned refuse collection and disposal. ASCE Proc. Paper 1014, J. San. Eng. Div. 82 (SA3) 13pp, June 1956.

This committee report summarizes a report by Mr. A. M. Rawn, Los Angeles County Sanitation Districts (see 252) made after 7 years' study to develop a plan for refuse collection and disposal.

Refuse is classified into: garbage, combustible and non-combustible rubbish, and refuse from industry. Quantities from both residential and commercial sources are given in pounds per capita per day. Collection costs for various types of services are given as calculated and as observed in the L. A. area. Disposal methods considered were: landfill, transfer and haul, incineration, garbage feeding to hogs, garbage grinding, salvage of non-combustibles, composting, and grinding rubbish to sewers. The following general conclusions are presented:

"(1) Once a week collection of mixed refuse is the most economical over-all collection system. Separate collection of garbage, combustible and non-combustible rubbish is more costly than combined collection, even though hog feeding and monetary returns from salvage are considered.

150. "(2) Refuse transfer and haul systems enable the economical employment of landfills in relatively remote areas. Improved transfer station design and large transfer truck vehicles may provide a lower cost refuse disposal system than alternate methods under most operating conditions.

"(3) Possibilities of utilizing water conveyance in sewers for the transportation of ground refuse to a treatment works appear encouraging for future development.

"(4) Numerous aspects for collection and disposal of refuse are carefully reviewed and analyzed in connection with their pertinent operating and cost characteristics. This fund of data is summarized in the report discussion.

"(5) Additional research of sanitary landfill, incineration, and other components of the refuse disposal system are needed for further development of the refuse disposal field.

"(6) Over a 6-year period diverse information concerning refuse collection and disposal has been carefully compiled and developed for application to a planned refuse disposal program for Los Angeles County. This information, although not all of it directly applicable to other municipalities, has much fundamental data that should be of interest to the engineering profession."

151. Amer. Soc. of Civil Engrs. (Committee report): Status of refuse collection and disposal, ASCE Proc. Paper 1176, J. San. Eng. Div. 83 (SA1) 7pp Feb. 1957.

(This is a report of a preliminary survey made in 1955-56 by the San. Eng. Research Comm. in the field of refuse collection and disposal. This abstract includes only that portion referring to composting as a means of refuse disposal.)

Current research in composting is conducted (a) by the Public Health Service, Communicable Disease Center in laboratory scale investigations at Savannah, Georgia and field-type composting studies at Phoenix, Arizona; (b) by the World Health Organization in night soil-refuse composting at (Kobe) Japan; (c) by Yale University, supported by the Ford Foundation through Resources for the Future, Inc., on "how waste materials such as organic refuse can be conserved to produce fertilizer and other products"; (d) by V. A. M., a government-supported organization, "in evolving an improved refuse processing system for converting organic wastes into either composted material or disintegrated refuse" in the Netherlands.

"The relative neglect of refuse engineering research and development can be summarized as being the result of a lack of appreciation by governing bodies and other agencies of the importance of good

151. refuse disposal practices to both serve and economically protect the health and welfare of a community.

"Many of the authorities contacted believe that composting is an interesting refuse processing system requiring further low cost development to achieve practical application in American municipalities. McGaughey suggests that there should be further investigations on the extent of nitrogen losses and means of controlling those losses in composting. Mallison believes that future mechanization of composting may improve the operational and cost picture. Peters recommends additional applied large-scale research in composting solid wastes to develop methods of controlling fly, rat and odor nuisances."

152. Amer. Soc. of Civil Engrs.: A survey of the present status of refuse engineering research and development. ASCE Proc. Paper 1539, J. San. Eng. Div. 84(SA1) 6pp Feb. 1958.

This is a report of the Sanitary Engineering Division Research Committee, ASCE, on the "present professional status of refuse collection and disposal activities in the U. S. and abroad".

International activities briefly discussed are research by: Inst. of Public Cleansing, Great Britain; WHO - Japanese Government on composting at Kobe; an International Working Party on Composting; the V. A. M. Company in the Netherlands; the South African Council for Scientific Industrial Research. U. S. work mentioned: the Public Health Service on incinerators and composting; the AEC and Harvard on incineration; the Bureau of Mines, New York University, UCLA, and University of Detroit (incineration); Michigan State University (composting); University of Washington (sanitary landfill); American Gas Association and Batelle Mem. Inst. (incineration); and APWA and ASCE (manual preparations).

It is concluded that "refuse collection and disposal engineering practice is a relatively neglected area of engineering knowledge. The State Health Departments and other authorities have, with rare exception, reported that they have no knowledge of refuse engineering development projects taking place in their areas."... "The field of Refuse Engineering appears to be gradually developing on the American scene as an organized body of knowledge. Increased suburban growth has resulted in the need for higher standards of refuse collection and disposal. Additional research and development programs can aid in reducing the cost of solid wastes handling. There is also need for further specialized professional training and organization of the engineers involved in refuse handling systems."

153. Amer. Soc. of Civil Engrs.: Refuse composting experience in the Netherlands. ASCE Proc. Paper 1610, J. San. Eng. Div. 84(SA2) 3pp, Apr. 1958.

153. Mr. W. A. G. Weststrate, Director of "V. A. M." Company (Amsterdam) furnished data for this report by the San. Eng. Research Committee. The "V. A. M." Company is a government-subsidized agency which contracts with Dutch municipalities to dispose of their refuse for about 8 to 36 cents/cap/yr. Salvaged material also helps to pay disposal costs which are incurred by composting. About 1/4 of the wastes in the Netherlands are processed to compost. The two largest plants are at Wijster and Mierlo with the refuse arriving by special train. It is moistened and composted in huge windrows for 4 to 8 months. It is then screened, sorted and ground in a "Rasping Machine". The screens and rasping machines were developed by V. A. M. Compost is freed of metals (salvaged), glass, and clinkers and is applied by farmers in amounts of 13 to 17/tons/acre every 4 years. Chemical analyses of compost: Organic matter (including unburnt coal) 4.5-12%; N 0.4-0.5% P_2O_5 (sol. in mineral acid) 0.4-0.5%; K_2O (soluble in water) 0.2%; CaO (sol. in mineral acid) 3.0%; MgO (sol. in mineral acid) 0.3%; CO_2 1.5%; H_2O 30%; loss on ignition 18-25%. The C/N is less than 20. There is a good demand for compost on the sandy soils of the Netherlands.

154. Anon: Sewage in the Sea 4: There is a future for composting. Reprint from: Municipal Engineering pp 13, 15, 1956.

This fourth article of a series advocates composting of refuse and sewage sludge as opposed to incineration of refuse and sewage disposal to sea. Composting has been practiced for centuries and recently a WHO monograph was issued which predicts more and more compost production. The waste from an agricultural standpoint of other methods of waste disposal is lamented. "The capital investment in the slow conversion of our sanitary and refuse disposal systems to produce humus for agriculture and horticulture is for the most part, no more than the cost of replacing obsolete plants and there is an expanding market for the product among those who are directly concerned with soil fertility" (according to J. C. Wylie). Mr. N. G. Wilson said, "When house refuse is composted with sewage sludge, a material is produced which has been shown to be of the greatest benefit to the soil".

Municipal composting began in England in 1936 under Mr. J. L. Davies at Leatherhead. Gifford and Nantwich have evolved their own methods of composting. Mr. J. C. Wylie has done real groundwork at plants in Dumfriesshire at Dalscone, the Barony, and Kirkonnel (Scotland). Jersey, Channel Islands, is a classic example of a comprehensive scheme of composting and a new plant is under construction there for a population of 40,000. Edinburgh was first to tackle the problem on a full scale under Mr. N. G. Wilson with the first Dano biostabilizer in England. The purchase of 3 more Dano plants has just been approved by the Department of Health for Scotland. The Dano plant (1955) treats 20 tons of refuse/day with 150 gals. of sludge/ton of refuse. Compost is rapidly sold at 2 pounds sterling/ton, ex works. The Department of Bacteriology at Edinburgh and East

154. of Scotland College of Agriculture stated that pathogens are completely eliminated after a few hours at 120°F.

155. Anon: The proto-type high rate composting plant of garbage and night soil in Kobe City, Japan. WHO Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 5 pp, Oct. 15 - Nov. 1, 1956.

A composting plant to treat 20 tons of sorted, ground refuse and 10 tons of nightsoil or anaerobically digested night soil "during 2 days' detention" has been constructed with government and WHO support. Process steps are: feeder, picking conveyor, grinder, storage, mixer, a 3-deck (Crane-type) digester, curing and storage bin. There is a night soil tank and pump. The grinder is a vertical swing-hammer type operating at 1800 rpm, driven by 100 HP motor. The storage bin holds ground refuse so it can be fed to the digester over 24 hours/day. The mixer is a screw conveyor to mix ground refuse and night soil. The digester has 3 stories each of two compartments with horizontal axle fitted with blades set at 120° to give the mixture a spiral flow horizontally. Ten percent recirculation on each stage will be practiced and total detention in the digester is 2 days. A blower is provided with air piping to the bottom of each story. The digester is 3.2 m x 7.5 m x 4.0 m high and the shafts revolve at 0.2 rpm.

The curing bin in 3 sections is a total of 10.8 m long x 5 m x 2.5 m high. Curing will be for 48 hours with forced aeration by means of a blower. This unit also serves as compost storage for removal by trucks. Construction and estimated operating costs are given.

156. Anon: Symposium sur les problèmes acuels de l'evacuation, du traitement et de l'utilisation des ordures ménagères (Symposium on the problems of removal, treatment and use of household wastes). Revue Suisse d'hydrologie 17, 369-518, 1955; PHEA 36 (12); GR5, Dec. 1956.

The symposium resulted in 15 papers which were summarized on pp 517-8. PHEA translated the summary.

Extracts: Incineration, composting or putrefaction of wastes are envisioned as most effective treatments. "The symposium was primarily concerned with the problem of treatment of wastes, of their transformation into compost, and the utilization of this in agriculture, horticulture and silviculture." Machines should be available for reduction of wastes, reduction of unpleasant odors, and improving the ability of microorganisms to reduce the wastes to compost. "Different stages in the process should be studied and methods of analysis found to improve the finished product and make it more usable." ... "In general the resulting compost can be used on any soil but especially in calcium-poor areas. Determination of soil deficiencies will indicate places where compost can be used to best advantage."

157. Anon: Composting municipal refuse. Research Review (South African Council for Scientific and Industrial Research) 7 (3) 80, Sept. 1957.

The South African National Chemical Research Institute and National Mechanical Engineering Research Institute have collaborated to construct a pilot composting plant for urban wastes. "The plant consists of a slightly tilted horizontal drum, 32 feet long and 10 feet in diameter, which rotates very slowly. The charge fills 95 percent of the drum and consists of a mixture of refuse and some sewage sludge. Air is injected tangentially into the drum through nozzles which are cleared of dirt automatically once every revolution. The waste materials are introduced at one end of the drum after passing through auxiliary pre-treatment equipment and about a week later should emerge as a biologically stabilized organic material at the other end. After mechanical screening and subsequent maturation a high quality compost results." Plant construction, financed by the Pretoria Municipality, has commenced.

158. Anon: Experiences with the use of refuse compost in the Netherlands. Mimeo, 13pp. Nov. 15, 1957.

Use of artificial fertilizers began in the Netherlands around 1900 and crops increased 25 to 50%. Chemically poor waste lands could also be cultivated. Interest in organic manure slackened. Cities were forced to dump or incinerate their garbage. After 20 or 30 years it was seen that it became more and more difficult to maintain high levels of production by use of even larger amounts of artificial fertilizers. In 1925 it was discovered that plants require adequate oxygen as well as plant nutrients and water. Soil structure must be good (crumbly) with a total pore space up to 65 percent of total soil volume. Such a structure can be obtained and maintained by regular application of organic manure.

Interest in organic manures and in city refuse was revived. The first mechanical plant for refuse composting was completed in Holland in 1932 and now more than 25 percent of the Dutch refuse is being composted. Refuse treatment plants must be located in agricultural regions and produce a cheap product such that the compost sells at the farm for not more than 10 Gulden/ton.

Average crop yield increases are 5-6% and vary from zero to 50% with the use of compost. Variation depends on soil type, weather conditions, kind of crop, and possible soil exhaustion due to parasites. Average Dutch refuse compost contains 0.4% N, 0.4% P_2O_5, 0.2% water soluble K_2O, 3% CaO, 0.3% MgO, and almost all trace elements in hundredths to thousandths percents. As the Dutch farmer uses fertilizer generously, the N, P_2O_5 and K_2O values in compost will have no influence on the yield ordinarily. Compost increases pore space and water-holding capacity of soil and decreases

158. effects of wind and water erosion. Best results are obtained with compost-loving crops such as mangold, sugar beets, potatoes, barley, rape seed, lupin, red and white clover and such horticultural crops as cabbage, cauliflower, spinach, endives, beetroot, tomatoes, cucumbers, and strawberries. Compost prevents trace element deficiencies, particularly of copper, boron, molybdenum, magnesium, and manganese. A number of other benefits and examples of crop yield increases are given.

159. Anon: Manufacture of compost as a means of garbage disposal. Munic. Util. 95(5)44-49, 1957. Water Poll. Abs. 31, 159, Jan. 1958.

"A description is given of the methods used for the preparation of compost from garbage in the Netherlands, and the possibility of their use in Canada is discussed. The basic procedure of the process is that either the refuse is allowed to ferment for 4-6 months and is then reduced; or it is first reduced to a fine mass and is then allowed to ferment. In the latter procedure, fermentation takes only 4-6 weeks by which time a fertile manure is produced. The 3 processes used in the Netherlands, the 'van Maanen', 'rasping', and 'Dano' systems, which are all based on one or other of the above procedures, are described and illustrated by diagrams. Although the cost of any one of these methods is approximately the same as that of garbage disposal by other methods, such as incineration, the preparation of compost for use as a fertilizer results in the growth of improved farm products which is of great economic importance." (WPA)

160. Anon: Composting fizzle - reopening of heralded plant appears doubtful. Eng. News-Rec. 33 Jan. 16, 1958.

The McKeesport, Pa. composting plant of Organic Corp. of America, ORCOA, was idled on August 11 because of non-payment of bills and payroll. H. G. Burr, ORCOA President, was arrested for passing worthless checks. He complained that the $250/month fee paid to the city by ORCOA was too liberal and negotiated for a new contract. The city contracted for sanitary landfill disposal elsewhere and on December 4 filed suit against ORCOA to acquire the plant. The plant reportedly cost $450,000 and ORCOA was capitalized at $1.5 million. The fertilizer (compost) was marketed for $64/ton in 50-lb bags and $135/ton in 5-lb bags. There is no indication that the plant will reopen. (Ed. note: In April 1959 the plant was still inoperative and another private firm was negotiating with the city for composting contracts.)

161. Anon: Conversion of household refuse into humus by a new method. Composting. Tech. Sanit. Munic. 51, 254-256, 1956. Water Poll. Abs. 31, 634, Mar. 1958.

"Several methods of disposal are discussed briefly. The composting of garbage and the uses of the humus produced are described." (WPA)

162. Anon: (Editorial): Salvage from refuse is desirable but rarely practical. Pub. Wks. 89(3)7, Mar. 1958.

It has not been shown so far that it is practical for a city to make money, or even to reduce materially the cost of refuse operations by salvaging. Composting by a private organization with adequate sales facilities can be made to yield a profit in some areas. Present refuse disposal needs are: tight, well-covered containers, better collection by modern equipment, and better disposal by incineration or sanitary fill. Current research on composition and characteristics of refuse may provide information needed for wider use of salvage methods, whether composting, grinding, and recovery of sludge gas and solids, or sale of materials gleaned from the refuse. "But no city can afford to wait very long, meanwhile relying on those methods which ought to be outlawed everywhere - the open dump and feeding to swine."

163. Anon: Compost plant in Jersey. Contract. Rec. 68(48) 20-23, 1957. Water Poll. Abs. 31, 636, Mar. 1958.

"A plant for composting household refuse and sewage sludge has been built in Jersey, Channel Islands, England. Refuse is screened and non-compostable materials are removed by hand and ferrous metals by a magnetic separator. The remaining material is pulverized, mixed with sludge and dust, and loaded into fermentation cells. The cells have six floors, one above the other, the contents of a cell being released each day to the floor below. After leaving the cells the compost is left to mature for about eight weeks." (WPA)

164. Anon: Compost plant to replace dumps in Bangkok. Amer. City 73(4) 29, Apr. 1958.

Quote entire article (news item): "Bangkok, Thailand (population 1,000,000) recently engaged a British firm (Ed. note: John Thompson Industrial Constructions, Ltd., London) to construct what is reported to be the world's largest mechanized refuse composting plant. The plant, being built in a suburb of Bangkok and scheduled for operation in 1959, will produce nearly 90,000 tons of humus-forming compost a year. It is designed to receive 1,100 cu m (1,438.8 cu yds) of refuse daily.

"The process involves three stages. First, all unsuitable material is removed from the refuse by magnetic and manual sorting. All salvageable material is then separated for sale. Finally, the remaining compostable material is shredded mechanically and refined in ballistic separators which remove fragments of non-ferrous metal and ceramics before sewage sludge is mixed with the garbage to form the raw compost. Mechanical conveyors distribute the mixture into special chambers where fertilization and digestion (Ed. note: seeding and aerobic decomposition) take place. The

164. process insures that the refuse generates sufficient natural heat to kill all dangerous germs and sterilize weed seeds.

"Some time ago the Thailand Department of Agriculture set up a pilot plant to test this projected disposal method. These tests effectively proved that compost of value as a fertilizer will be produced in the new plant.

"The composting process can operate with or without sewage sludge. If sludge is not used, the garbage can be mixed with water. Present plans at Bangkok call for certain quantities of dried sludge to be brought to the site and added as required." (Author)

165. Anon: Automatic pipeline dry wastes disposal system. Ind. Wastes. 3(3) 12A May-June 1958.

The Conservomatic Corp., Oreland, Pennsylvania has developed the "Conservomatic System" to wet grind refuse (garbage, paper, glass, cellophane and other wastes), remove excess water, and extrude the wastes in an "odorless pulp". Water is either recirculated to the pulper or discharged to the sewer. One model handles a ton of refuse per hour and reduces wastes up to 80 percent by volume, it is claimed. The pulp can be disposed of by normal composting.

166. Anon: Modern composting plant for Bangkok. Chem. & Ind. 91-92 1958. Water Poll. Abs., 31, 1246, June 1958.

"The composting plant in Bangkok, Thailand, is designed to process 1,100 cu m of refuse daily. After removal of unsuitable material, the garbage is shredded mechanically, refined in ballistic separators, and mixed with sewage sludge. The crude compost so formed is allowed to ferment aerobically in such a way that the temperature/duration conditions produced are lethal to harmful organisms. The material is automatically turned and aerated as it is passed downwards from floor to floor in the 6-story composting house, and is sterilized by the heat developed in the fermentation process. After removal from the composting house, maturation of the compost is completed in stockpiles; after 6 to 8 weeks the compost has a balanced nitrogen:carbon ratio. About 80,000 tons of humus-forming compost will be produced annually." (WPA)

167. Anon: (Editorial): Composting--is it worth-while? Roy. Soc. of Health Jour. 78(4) 293-4, July-Aug. 1958.

Interest is increasing in the possibility of producing compost from house refuse or other organic matter and sewage sludge. Work at Leatherhead and Maidenhead 30 years ago produced no outstanding results and "did not establish beyond doubt that the production of a satisfactory compost was a practicable proposition". Recent interest is evident with proposed plants at Bangkok and Leatherhead,

167. and at Jersey compost is being produced. One technical journal advocates "composting as a method of utilizing refuse and sewage sludge without reservation". "Certain agricultural interests have for years given it unqualified support." Yet the Maidenhead Council abandoned the system after studying it for years with the Agricultural Research Council and Reading University. Although other agricultural studies have been made, "it is significant that none of these bodies has ever advocated the general adoption of composting as a means of improving soil fertility or as a method of combatting soil erosion."

The author recommends that "professional bodies interested in refuse and sludge disposal problems and the recognized agricultural and horticultural research organizations should get together to examine composting in all its aspects and issue a report on the economics of the system from the point of view of both the local authority and the farmer". He suggests formation of a Working Party. (see discussion: 186)

168. Anon: On-site refuse quantity study. Pub. Wks. News Letter 25(8) 2, Aug. 1958.

The Public Works refuse disposal committee is sponsoring a "study of the amount and type of refuse collected and disposed in selected American cities". Procedures for collecting data were first tested in Washington, D. C. and then in New York City. Mr. E. R. Williams of USPHS is making site visits. Completed studies are in Washington, D. C.; New York City; Garden City, L. I.; Hartford, Connecticut; Chandler, Arizona; Los Angeles; and San Francisco. Scheduled for August and September are Atlanta; St. Petersburg, Florida; Cincinnati; and Omaha. The information will be used in an APWA manual, "Municipal Refuse Disposal".

169. Anon: Michigan city composts its refuse successfully. Refuse Removal Jour. 1(9) 14-15, 32, Sept. 1958.

Williamston, Michigan (2500), operates a refuse-sewage sludge composting plant built 3.5 years ago by the Sanitary Disposal Corp., Lansing (Ralph Riker, Research Director). Sewage solids are removed from primary settling tanks and filtered to 65% moisture in a Komline-Sanderson Coil-Filter. Glass is picked out and ferrous metals removed by a magnetic pulley. Refuse and sludge cake are mixed, inoculated with bacterial culture, and ground in a hammermill. A Hapman tubular conveyor transports raw mixture to the composter and also compost to the storage bin. Two 4-compartment chambers are provided for composting. These are vertical cells with clam-shell bottoms designed to drop compost in stages. Forced air is provided and material is dropped at 5-day intervals (requiring 20 days). Capacity of the two units in parallel is 40 tons (based on fresh wt.) giving a plant capacity of 2 tons per day.

169. The mixed waste composting costs $3.40 to $3.75 per incoming ton or not over $7.00/ton of compost. It sells to greenhouses, home owners, and farmers at an average of $40/ton.

170. Anon: A modern composting system for the city of Bangkok, John Thompson Ltd., Mimeo, 4pp and photograph (undated).

Bangkok Thailand, populatica 1,000,000, will soon have the largest mechanized compost plant ever built. The contract has been awarded to John Thompson Industrial Constructions Ltd. of London, working with another London company which specializes in study and design of composting processes. The plant should produce 80,000 tons of compost annually for sale to farmers and gardeners. Cost of the plant will be 714,000 pounds sterling to be paid by the Municipality of Bangkok.

The plant is designed to receive 1,100 cu m of refuse daily. Magnetic and manual sorting will be used to separate salvage. The remaining garbage (refuse) will be shredded mechanically and "refined in ballistic separators", designed to remove metals, ceramics, etc. Sewage sludge will be mixed with the refuse and the mixture will be conveyed and distributed mechanically to the composting floors or cells. Mixing is accomplished by double-screw, broken-flight, opposing blade mixers 12 ft long with 2 ft diameter screws.

The composting house has six floors, the bottom being 9 ft above ground, the remaining being spaced at 5 ft 3 in centers. Troughs in series form the floor; material enters the top and passes to the floor below when the floor trough is inverted. Each row of troughs has 72 units 10 ft long, of semi-cylindrical section, 4 ft wide at the top. Troughs are perforated for aeration. The compost is matured in stock piles for 6 to 8 weeks. Most will be sold in bulk but some will be finely shredded and bagged.

An analysis of the Bangkok refuse showed:

Paper and cardboard	4.0%	Tins, metal	2.3%
Rags, string, etc.	5.4%	Rubber	0.6%
Vegetable wastes	47.5%	Glass, ceramics	1.9%
Meat and fish wastes	0.7%	Miscellaneous refuse	13.5%
Dust, ash	24.1%		

171. Anon: (News item): Large compost plant now in operation. Organic Gard. and Farm. 5(12) 35, Dec. 1958.

The Organic Compost Corp. (George Klein, President) operates the largest compost plant in the U. S. today at Germantown, Wisconsin.

171. An aerial view shows a huge pile of material plus 15 windrows on the ground in a farming area. (Ed. note: The article does not say what wastes are composted.) Klein and his plant manager built a compost turning machine operating under its own power through the windrows "thoroughly lifting and mixing the materials". The operator rides 12 feet above the ground. The machine cost $14,000 but Klein claims it can be duplicated for about $8,000.

172. Aybram: Construction of the sewage works. Tech. Sanit. Munic., 52, 2-8, 1957. Water Poll. Abs. 31, 1212, June 1958.

"A brief historical description of the development of the sewerage system of Toulouse is given and the new sewerage system and sewage works constructed since the occupation are described in detail. Sewers for storm and waste waters were, in general, laid side by side at the same time. At the sewage works, large solids are removed by screens, disintegrated, and returned to the sewage before it is treated in a conical tank, where floating grease is removed, and in upward flow sedimentation tanks using iron hydroxide as coagulant. 95% of the solids are removed by this process. The effluent is chlorinated and discharged to the river Garonne; and the sludge is digested anaerobically at 25°C, dried on beds, mixed with absorbent material such as straw or sawdust, and used as compost. Some of the methane envolved in the fermentation process is used to heat the digestion tanks and it is proposed to use the remainder commercially." (WPA)

173. Beatty, Russ: Garbage converted by ORCOA into rich organic fertilizer. Penn. State Farmer, Forester and Scientist 8(3) 10-11, 13, Mar. 1957.

Organic Corp. of America (ORCOA) tested a pilot plant built in Miami in 1953 and constructed a 150-ton/day refuse composting plant at McKeesport, Pennsylvania in 1956 for a city of 50,000. Refuse is conveyed past magnets to two grinders, inoculated with a "special bacterial culture" and trucked to a fermentation area. Temperatures of 140-175°F develop and "a rigid schedule of moisture and oxygen additions is followed for 14 to 21 days" when the compost is either sold in bulk or screened, bagged, and sold under the name ORCOA. The N-P-K contents are reported each to be 1.5 and the compost is claimed to contain all trace elements.

174. Beccari, Giuseppe: Apparatus for working garbage and refuse of towns. U. S. Patent 1,399,105. Applied for Mar. 21, 1916; Patented: Jan. 27, 1920, (reissued). 5 Figs, 7 claims.

Manure or refuse from the town is introduced at the top of one or more fermentation chambers through a trap door and sprinkled with water or sewage and alkaline powders. Air channels and gratings are provided. Temperatures reach 60-70°C. The material is wetted to regulate moisture during the first 20 days and fermentation is complete in 40 to 50 days. Exhaust towers have coated baffles to

174. trap and fix ammonia that may come off. The discharge door is at the bottom. The fermented matter may be used in agriculture or for fuel.

175. Bourdier, L.: Fertilization for vineyards. IRGR (5) 18, Mar. 1959 (Dec. 1957 - French).

(see IRGR)

176. Bowerman, F. R.: Los Angeles' answer to the long-haul problem. Amer. City 73(10) 132-4, Oct. 1958.

The ban in L. A. County on home incinerators has resulted in a sudden, heavy increase in trash volume. The County constructs and operates sanitary landfills and transfer stations to supplement city and private disposal operations by means of the County Sanitation Districts. Actual refuse collection is municipal or private. Districts' plans include 5 landfills and 20 transfer stations, there being two landfills in operation now. This article describes the first transfer station, located in South Gate and starting operation in January, 1958. Hauls from the station are: Rubbish--23 miles to the Palos Verdes landfill; garbage--35 miles to the Spadra landfill.

Collection trucks discharge from an elevated ramp directly into transfer trailers. Each trailer holds 57.5 cu yd or about 10 tons of refuse. A complete unit consists of a truck-tractor and two trailers, hauling about 20 tons of refuse. Charges are assessed on a weight basis, except for certain special materials, and a motor-truck scale weighs each load. Disposal charge at a landfill is $1/ton and transfer hauling charges are $1.75/ton. Regular customers use plastic credit cards and, once the tare weight of a given truck is established, empty trucks are not re-weighed. Weighing stations are used at each landfill for direct haulers.

177. Bradley, C. L.: The profitable reclamation of municipal wastes. The Sanitarian 19, 210-11, Mar.-Apr. 1957. PHEA 38(4) GR-2, Apr. 1958.

"Composting has been carried on by populations needing to replenish soil fertility. The modern approach is to combine increased fertility and profitable refuse disposal. Since World War II, there has been an increase in plans for reclamation by biological methods, some with 'secret inoculums' for which, according to data available to the author, there is no necessity. Decomposition depends on standardized environmental conditions. The basic steps of the process are: '(1) Receiving, (2) Segregation, (3) Compost preparation, (4) Decomposition and stabilization, (5) Preparation as a marketable commodity.' Receiving is carried on in any collection system regardless of final disposition. Segregation and preparation are necessary where mixed refuse is collected. Decomposition is initiated under controls and final decomposition and stabilization completed

177. in open air windrows on unimproved land, creating minimal nuisance problems. Decomposition creates its own heat." (PHEA)

178. Braun, R.: The rubbish problem in Switzerland. IRGR (1) 24, May 1958 (1956).

(see IRGR)

179. Brillantes, Bonifacio P.; Concepcion, Ricardo.; Suarez, Igmidio G.; and Lesaca, Reynaldo M.: The collection, disposal and utilization of organic wastes in the Philippines. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 23pp and 18 App, Oct. 14 - Nov. 1, 1956.

(This abstract covers only the composting activities discussed).

The Dept. of Public Services, City of Manila, conducted an experiment on composting in February 1954. About 40 cu m (11 tons) of mixed refuse, including horse manure, slaughter-house wastes, leaves, and grass, were composted outdoors on the ground in a pile about 1.2 m high without sorting. During the first 9 days, turning was done every 3 days; thereafter, turning was done every other day to a total of 30 days composting. Turning was done with a crane and clam shell bucket and removal of non-putrescible materials was accomplished during the turning process. Initial moisture was about 60%. A strong foul odor was evident the first week and foul liquid leached from the pile after a week. Flies were present in the first few days and were abundant in the second week but then diminished. Maggots were observed even after a week.

The temperature rose to 60°C on the 5th day, then dropped as a result of over 3 in of rain from a typhoon, but recovered to 68°C on the 8th day. The peak temperature was 70 C, reached on the 15th, 18th and 20th days. The temperature dropped to a fairly steady 52°C in about 30 to 34 days. The color changed from greenish-brown to brown and to dark brown after the 7th day. After the 22nd day, the color changed to pale brown. On the 8th day a volume decrease of 40% was observed; the final volume reduction was 60%.

Total wet weight loss was 20% and 62.5% of the final 8000 kg passed through a 1 in screen. The screened material therefore was 50% of the initial weight. Cost per ton was 50 Philippine pesos. Compost analyses: moisture 5.3%; ash 38.9%; CaO 3.3%; K_2O 0.34%; P_2O_5 1.14%; N 0.68%; C/N 32.8. The Phillippine Bur. of Soil Conservation tested the compost agriculturally in growing Chinese pechay plants. Compost with ammonium sulphate was best, compost next, and soil without compost was poorest.

Field studies made by the city in early 1956 with the use of bacterial inoculum were made. Two strains of Bacillus subtilis, isolated from decomposing matter at the dump site, were used. Material used was mainly meat and vegetable wastes which had been pre-sorted. The

179. first turning was on the 4th day, thereafter every other day (12 turnings in all). Flies and foul odors were observed for the first week. There was not much difference between the control and the inoculated piles.

180. British Organic Products, Ltd.: An improved process for the treatment of sewage or other organic liquors and domestic refuse or other organic matter. (B. P. 764, 294) Water Poll. Abs. 30, 312 (Sept. 1957). PHEA 88, S23 (Mar. 1958).

"A process is claimed for the treatment of sewage sludge or organic liquor, having a BOD of at least 5,000 ppm, a pH value of 6.5 to 7.3 and a N-content of at least 100 ppm, by fermentation under anaerobic conditions, admixture of the digested sludge with finely divided organic refuse, dewatering by vacuum filtration, and aerobic fermentation to yield a compost. The apparatus used in the process is described and illustrated in appended diagrams; it incorporates features for the maintenance of an anaerobic digestion temperature between 45 and 55°C, agitation of the contents of the digestion tank by circulation of liquor through nozzles, and the prevention of scum formation. Composting of the mixture of digested sludge and organic solids, seeded with up to 10% matured compost, is carried out for 3 to 5 days in ventilated cells and subsequently in the open for a period of about 12 weeks before the compost is applied to the land." (PHEA)

181. Buck, K.: Fresh refuse and refuse compost for improvement and fertilization of soils. IRGR (4) 18, Feb 1959 (1956 - German).

(see IRGR)

182. Buck, K.: Making refuse and refuse-sludge composts and testing their fertilizing values. IRGR (5) 16-18, Mar. 1959 (1958).

(see IRGR)

183. Busching, W. B. P. 748-527 (Aug. 12, 1953): Destruction of organic components in factory waste liquors. J. Appl. Chem. 7, 340, May 1957. PHEA 37(11) S-89 Nov. 1957.

Patent: "The waste liquors, after suitable neutralization, if desired, are sprayed through atomizing nozzles into the top of a combustion tower heated by hot gases, whereby the liquor is evaporated and solid organic matter burnt. Dust is removed by a separator operating above the dew-point, and the vapor condensed and discharged as safe effluent in a spray condenser. An ejector continuously withdraws organic residuals and combustion residues from the base of the combustion tower and reintroduces them into the upper part." (PHEA)

184. "Compost" Foundation (Stichting "Compost"): The Preparation and the use of compost derived from city refuse in the Netherlands. (De bereiding en het gebruik van stadsvuilcompost in Nederland). Stichting "Compost" Amsterdam. Brochure 44pp, March 1956 (with mimeo. English summary 5pp); Abs. IRGR (2) 8-11, Oct. 1958 (English).

Improvement in soil fertility is one of the main Dutch problems of our time. More attention is needed to adding organic matter to the soil. The Dutch government has made available Marshall-funds to the "Compost" Foundation to develop and test methods of composting city refuse. Chapter I discusses the importance of soil to the Netherlands economy. Chapter II explains soil fertility, distinguishing between chemical fertility and physical fertility. Chapter III covers the decline in soil fertility brought on by exhaustion and by wind and water erosion. Chapter IV shows the need for greater use of land and increased yields because of the dense and growing population of the Netherlands. Chapter V describes 3 modern composting systems: van Maanen, rasping, and Dano systems. A quarter of all refuse in Holland is now being composted. Chapter VI gives average analyses of Dutch refuse compost and action of the total and some of its components on crops and soils. Chapter VII gives recommendations on quality and quantity of composts suitable for various soils and other agricultural uses (chicken ranches, pig farms). 15 ill.

185. Cosack, J.: The reforestation experiment at Zonser Heath. IRGR (3) 8-10, Oct. 1958 (1957 - German).

(see IRGR)

186. Davies, A. G.: Composting - is it worth while? (Discussion) Roy. Soc. Health Jour. 78(5) 526 Sept. - Oct. 1958.

In a letter to the editor, Davies (Woking, England) points out that there is a Joint Working Party (on composting) chaired by Lord Douglas of Barloch and with representatives from the Association of Public Health Inspectors, Institute of Public Cleansing, and the Soil Association. A draft of report of this committee should be issued soon. (see 167).

187. DeFraga Frangipane, E.: Preliminary considerations for establishment of a treatment plant for municipal refuse. IRGR (4) 16, Feb. 1959 (1956).

(see IRGR)

188. deGroote, R.: Analysis and evaluation of the quality of refuse compost. IRGR (3) 3-7, Oct. 1958 (1957 - German).

(see IRGR)

189. Engineering Society of Detroit: Report on garbage composting. J. Air. Poll. Assn. 6 (4) 237-9, Feb. 1957.

A bibliographic study and evaluation was made on garbage composting by the Engineering Society for the City of Detroit at the request of the Detroit Common Council (resolution of Dec. 1, 1953). Bibliography consisted of 620 references of which 158 were studied (covering the period since 1935). The principal conclusion was that "garbage composting either as a waste disposal or a waste recovery operation does not appear practical for adoption by the city of Detroit".

Anaerobic and aerobic decomposition were discussed with the conclusion that the former appeared to be definitely ruled out. There appeared to be confusion in the literature regarding the use of additives and buffers. There appears to be doubt as to the market in the U. S. for sale of compost. Costs of plants appear excessively high for mechanical units and there was insufficient information in which to base capacities and loading rates.

Value of composting in the U. S. appears to be as a waste disposal method, rather than as a waste recovery method. Composting presents encouraging aspects where land available for municipal refuse disposal is difficult to obtain and costly. The composting process, as regards the biochemical reactions involved seems to have been fairly well explored in California and by such agencies as Michigan State College. "The aerobic process has not as yet been proven satisfactory and as of this date there are no installations using this process, in operation in this country, except on an experimental or pilot plant basis." There is doubt as to the economy of the process for large scale operation.

Doi, Sei; Vemura, Susumu; and Takahashi, Kazuo. (see 227)

190. Duisburg Municipal Sanitation Office: The new compost plant at Duisburg-Huckingen in operation. IRGR (4) 10-11, Feb. 1959 (1958 - German)

(see IRGR)

191. Eweson, Eric: Profitable garbage disposal by composting. Kan. U., Sch. of Eng. and Arch., Bull. 29, Trans. 3rd Ann. Conf. on San.Engineering, pp 7-12, 1953.

Author deplores the gradual reduction in humus content of U. S. soils, pointing out that once-rich Mesopotamia, Persia, Greece, Italy now are barren deserts. Humus in this case is not peat humus which is decomposed anaerobically but the "rich, complex, living mass of end products from the microorganic process of decay - nature's composting process". "Chemical fertilizers can neither add to humus content nor replace it; instead they speed up the process of humus impoverishment, which is the main reason why we

191. are using up our soil fertility so much faster than other nations have before us." Values of humus are: a) great moisture-holding capacity; b) soil binder to prevent erosion; c) needed for thriving earthworm populations; d) contains nutrients and soil microbes which decompose and convert organic matter (i.e. leaves) into plant food.

Dr. Firman E. Bear (Rutgers) states, 'Soils must be fed with organic matter in larger amounts than the roots and residues of such (cultivated) crops can produce....In my opinion, we should lend assistance to efforts that are designed to avoid waste of organic materials. It might be well to subsidize the processing of such organic wastes as can be made available for use on intensively cropped land....Instead of looking with a jaundiced eye at the efforts of the organic-farming enthusiasts to develop organic matter supplies for use on the soil, the fertilizer industry would do well to interest itself in this problem.' ('The wrong turn', F. E. Bear, The Journal of Soil and Water Conservation, Apr. 1951.)

Progress in refuse disposal sanitation has been very slow. Composting, although an ideal solution, has not progressed in the U. S. due to time, labor, and skill required. The Frazer-Eweson process is then described emphasizing the need for CO_2 in the rapid decomposition phase of the period of composting. Temperatures of 150 to 170°F and time of 7 days are reported for the high-rate aerobic composting process, with the addition of ground limestone to regulate pH. Cost data: 25 tons of "kitchen" garbage per day, plant costs $100,000; claimed to be "self-supporting" with amortization in 5 to 10 years. Such a plant involves two 4-zone (cell) units in a space of 40 ft x 120 ft. Total personnel of seven are needed to operate the plant of the Frazer-Eweson type. About 10 percent of screen "tailings" will be returned to the plant.

192. Furkasdi, [illegible] The preparation and utilization of municipal wastes in Hungary. IRGR (5) 3-8, Mar. 1959.

(see IRGR)

193. Forest, H. S. and Furlow, H. G.: Engineering for microbiological environmental control in refuse composting. Proc. Okla. Acad. of Sci. for 1957, 38, 32-35, 1958.

Favorable conditions for biological decomposition of organic matter require readily available nutrients, moisture, oxygen, and heat. (Ed. note: Heat is a by-product rather than a requirement.) Various composting processes are discussed briefly as well as research work in the U. S. The "Naturizer" process is roughly described beginning with a pilot plant in Norman in 1955 and the present construction of a full-scale plant to serve the city. Parts of the plant are: storage conveyor, picking conveyor, "pulverator", moisture addition, grinder, 3-cell digester, secondary grinder, 3-cell digester.

193. The pulverator is a mixing device of novel design and the grinder is also of original design. Thermophilic aerobic decomposition of 6 days, dropping the material at 24-hour intervals from cell to cell is to be provided. Moisture to be added to the refuse may be water, raw sewage sludge, or swill. (Ed. note: Details of the plant are not given - no engineering data are provided.)

194. Forsyth, W. G. C. and Webley, D. M.: The microbiology of composting. II. A study of the aerobic thermophilic bacterial flora developing in grass composts. Proc. Soc. Appl. Biol. 34-39, 1948.

"A study has been made of the thermophilic flora developing in composts made from lawn mowings (Macaulay Inst. for Soil Research, Aberdeen). It has been shown that: (1) There is a rapid development of a thermophilic flora during the high temperature phase of the process; (2) this development takes place particularly in the upper layers where conditions are aerobic; (3) aerobic thermophilic bacteria appear to be abundantly present and can be isolated with ease on nutrient agar; (4) the presence of thermophilic actinomycetes is strongly indicated by direct microscopic methods, but difficulty is being experienced in isolating this organism for further study; (5) the thermophilic bacteria readily attack the protein and hemicellulose fraction of the grass, leading to the production of abundant ammonia and a relative increase in cellulose and lignin fractions." (Author's summary)

195. Gabaccia, A. J.: Organic sludge composting practice at Lederle. Paper presented at Sew. and Ind. Wastes Assn. annual meeting, typed 17pp, Oct. 8, 1958.

Pilot plant studies were conducted on composting vacuum-filtered sludge from the Pearl River, New York (antibiotic and pharmaceutical) plant of Lederle Laboratories with stable manure (25%), sawdust (10%) and phosphate rock (0.5%) in 1953. Composting was initially conducted in wooden boxes with daily turning. Trials were also made in the modified Earp-Thomas plant at Michigan State University, but the plant was not satisfactory for handling the wastes. Final composting was done in windrows in the open on a long-term basis because of adequate area being available. Time is about 150 days and large windrows (up to 15 ft high x 25 ft wide) are used after which the crude compost is partially dried and reshredded. In the past 3 years about 6 to 10 tons/day of organic sludges have been composted and sold through a local dealer as a lawn treatment and soil conditioner. Some chemical analyses are given. The pilot studies indicated the desirability of shredding frequently if faster composting is desired.

196. Geraghty, Cecil H.; Kennedy, Richard R.; and Seabrook, Chauncy S.: U. S. Patent 2,798,800: Composting Municipal Refuse. Chem. Abs. 52, 627-8, Jan. 10, 1958. PHEA 38(6) GR4, June 1958.

196. Patent issued: July 9, 1957. "A humus product is produced by stacking of unsegregated municipal refuse in windrows maintained at a suitable moisture content (40-60%), followed by tumbling every few days for 3-8 weeks. The temperature inside the windrows is 140-60°F. The mixture is then screened. The oversized fraction is rejected and the undersized fraction yields a finished humus product. If the C:N ratio is too high, it can be decreased by addition of supernatant liquor from anaerobic digestion of sewage sludge as a means of maintaining the moisture content. The humus product contains moisture 15-25, N about 1, P as P_2O_5 about 1, K as K_2O about 0.8, and C about 19% of the dry weight. The wastepaper content of the refuse is almost completely decomposed. Ferrous scrap is recovered by the screening followed by magnetic separation." (PHEA)

197. Gerretsen, F. C.: Research work in the treatment and utilization of urban domestic wastes. IRGR (1) 5-10, May 1958 (June 1956).

(see IRGR)

198. Gerretsen, F. C. and Campen, W. A. C.: The determination of domestic coal in refuse compost. IRGR (5) 10-14, Mar. 1959.

(see IRGR)

199. Goor, A.: Refuse disposal in Israel, and its relation to agriculture. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 7pp, Oct. 15 - Nov. 1, 1956.

Population growth (organized Jewish immigration) and various soil deficiencies, caused by intensive cultivation with only chemical fertilizers, require the use of organic fertilizer to improve quality and increase yield of agricultural products in Israel. Night soil is not used in Israel as it is "discouraged by regulation and taboo according to the Bible". Composted garbage (refuse) as a source of organic fertilizer is just beginning to be used.

The Kfar Macabi composting experiments, conducted in the center of 5 agricultural settlements with a population of 5,000 including the township, consist of refuse sorting and composting in 5 ft x 8 ft (width at base) x 300 ft long windrows. In the first 6 weeks the compost is watered and is turned weekly. The windrows are left for 4 months then compost is ready for distribution as fertilizer. Two laborers are used and the salary of one is paid for from the salvaged material sorted out. Net cost of composting is only 2.65 Israel pounds/metric ton or $1.33/US ton for the fertilizer.

At Tel-Aviv, an organization of businessmen reclaimed material from the refuse dump into usable fertilizer. The material, already decomposed, was manually sorted and rasped in a rotating perforated

199. drum with centrifugal hammer. The screened material was compacted in bales and sells for $2.78/cu m or about $0.16/100 lb not including loading or transportation. After use on the dump, this method was abandoned and a new method, developed by an Italian, Dr. Bejerano-Pico, was adopted. This experimental plant of 20 cu m/hr capacity provides a wide-mesh belt conveyor over a concrete bin to remove large items, conveying from bin, magnetic separation and hand picking, milling in a rotating, perforated drum, and composting in the open. Composting requires 3-4 weeks with turning every 3 days. Some fly problems resulted and it is now proposed to provide 2 days of anaerobic decomposition followed by 6 days of aerobic decomposition.

Another method of select garbage disposal is the semi-weekly feeding of carp in fish-ponds which increases fish yields.

200. Gordon, C. A.: Municipal composting in the United Kingdom. ASCE Proc. Paper 1852, J. San. Eng. Div. 84(SA6), 29pp, Nov. 1958

Composting is a disposal method and not a profitable operation. Economics are compared to other disposal methods. U. K. refuse amounts to 1.5-2.0 lb/cap/day with over 50% being dust and cinders by weight and only 3.7% garbage. Dust content changes from less than 30% in summer to over 50% in winter. U. K. sewage treatment is similar to U. S. but climatic conditions are poor for air drying of sludge.

Kirkonnel, Dumfriesshire, Scotland. Raw sewage sludge and refuse from 5,000 people are successfully composted producing about 550 tons of compost yearly. Steps are: receiving, conveying, screening, picking and magnetic separation, and shredding of the refuse. Refuse-sludge, augmented by straw, are composted in ventilated cells charged from storage and mixing bays by a 3-way traveling grab. Materials are layered in the mixing bay until full, removed to composting bays after 1 week and composted 5-6 weeks. Temperatures are 135°F in mixing bay, 180° peak the first week in cells, and 125° the last week. With salvage and sale of compost at $14/ton in 1- to 5-ton lots, net costs (not including amortization) are only $0.35/long ton. N is 1.0-1.3% and C/N is 15-20. Equipment difficulties are inefficient cinders' separation and excessive hammer wear.

Jersey, Channel Islands, England. This refuse-sludge plant serves 57,000 plus 37,000 in visitor season for refuse and 50,000 for sewage sludge. The sewage plant is not completed. The process includes: refuse storage, conveying, screening, automatic weighing, picking, magnetic separating, rasp-type pulverizing, ballistic separating. A traveling grab lifts the weighted mixture to the top of a 6-floor composting plant. Floors are semi-circular, perforated, roll-over units with compost held one day on each floor. Temperatures reach 140-160°F on 4th and 5th floors. The compost

200. is then matured 6-8 weeks in 6-ft piles in maturing bays. Compost sells at about $4.60/ton. Sludge will be thickened to about 90% moisture content before being added to the raw refuse. Net cost of disposal is expected to be only $22,400 compared to $70,000/yr (1956) for incineration. Agricultural tests on Jersey compost were satisfactory.

Three other plants are described briefly: Leatherhead, England; Edinburgh, Scotland; and a second Dano plant (Craigmillar)being built at Edinburgh.

201. Gotaas, Harold B.: Composting of municipal refuse. Conference on incineration, rubbish disposal and air pollution, Air Pollution Foundation-Report No. 3, pp. 35-36, Jan. 1955.

Composting in the U. S. has had little success, partly due to promotion of patented procedures which usually increase the cost but add little to the process. Recovery of large amounts of low value materials will not support these projects. Aerobic decomposition is more satisfactory than anaerobic because thermophilic temperatures are attained which destroy pathogens and weed seeds. If garbage is segregated, it will usually be more economical to use it as hog feed than to compost it. Composting is most economical with mixed garbage and rubbish. Factors affecting the process are: (1) Proportion of organic matter and C/N, (2) size of particles (under 2 to 3 in most satisfactory), (3) moisture content of refuse (40 to 70% satisfactory), (4) temperature (50 to 70°C), (5) aeration (1 to 3 turns usually sufficient), (6) pH. Refuse contains all the needed micro-organisms for biological stabilization, inocula are not required.

Mechanical units with forced aeration and stirring have been proposed to compost in 2-4 days instead of 10 days or longer. Yet demands for compost are seasonal so there is little economic advantage in increasing costs to compost rapidly only to have to store the compost longer. Present designs aim at minimizing initial grinding and facilitating segregation through suitable screening of incoming refuse. Final processing, screening, or grinding is more easily and economically handled.

Land area required for windrow composting is 2 to 5 acres/100,000 population. Economical composting must be done on a large scale - greater than 50 tons per day. In a large plant the cost may be kept as low as $2 to 3 per ton, or near the cost of incineration. (A dissenting opinion was given in the discussion, pointing to the $32/ton costs at Oakland, California).

Refuse compost has about the same nutrient value as stable or steer manure but is worth more because weed seeds are destroyed. "If the compost could be given away at the composting site, the cost of disposal by composting will be no more and probably less than

201. disposal by incineration. If the compost could be sold at the usual price of stable manure, the cost of refuse disposal by composting would be very much lower than that for incineration."

Chemical constituents of composts may vary widely in the following range, depending on the material being composted:

Substance	% by Wt (dry basis)
Organic Matter	25 - 50
Carbon	8 - 50
Nitrogen as N	0.4 - 3.5
Phosphorus as P_2O_5	0.3 - 3.5
Potassium as K_2O	0.5 - 1.8
Ash	20 - 65
Calcium as CaO	1.5 - 7

Berkeley refuse compost averaged: N, 1.5%; P_2O_5, 1.1%; K_2O, 0.8%; C, 28%; ash, 37%.

"Composting offers excellent possibilities for economical disposal of mixed refuse from cities in an area where there is a demand for the humus fertilizer." Agriculture can benefit from the nutrients in compost. But, as the economic margin in dealing with low value material is not great, efficient methods must be practiced and there must be an outlet for the fertilizer if profitable composting is to be assured. Composting will probably be first put on a commercial basis by private industry.

202. Gothard, H. A. S. B.P. 764,294 (Sept. 17, 1951): Treatment of sewage or other organic liquors and domestic refuse or other organic matter. J. of Appl. Chem. 8, 1-461, May 1958. PHEA 38(10) S-87, Oct. 1958.

Patent: "Organic liquor having a B.O.D. of about 5,000 ppm, a pH value of 6.5-7.3, and an N content of about 100 ppm is fermented under anaerobic conditions to yield methane-rich gas and digested sludge. The latter is then mixed with finely divided organic matter and fermented under aerobic conditions to yield a compost fertilizer. Plant is described." (PHEA)

203. Gothard, S. Averill, and Brunt, L. P.: The Zuckerman Report on towns' wastes: some comments. The Surveyor (Br.) 113 (part 2) 701-2, Aug. 14, 1952.

203. Argumentative comments on the report "The Use of Towns' Waste in Agriculture" by the National Resources (Tech.) Committee (Br.) under the chairmanship of Prof. S. Zuckerman (called here the 'Zuckerman Report'). There were prior "distortions"in the perspective of the report as few or none of the 15 committee members were directly concerned with either composting or handling towns' wastes. The report emphasizes the N-P-K content of sludges and composts but "says little of the soil conditioning properties which are held by many to be the principal virtue..." The authors agree with the committee in that composting is only a partial solution to the sludge disposal problem but point out that four parts of wet sludge (by wt) is successfully applied to one part of pulverized refuse at Leatherhead. Satisfactory composting was accomplished by J. C. Wylie at Dumfriesshire using ratios of 2 to 7 parts of sludge to 1 part of mixed dry wastes. "Composting should not be approached from the standpoint of disposal of sludge" as it is primarily for refuse disposal and good composts can be made with refuse alone.

The authors disagree with the report's cost figures which indicate 'little economic attraction' for composting sewage sludge-refuse. The cost of composting appears favorable, "so that the selling price of the compost can be fixed at a level which is economic to the farmer, and revenue accruing from its sale will improve the balance in favor of composting". Quotes from a government publication indicate that the key to desirable soil conditions for good crop growth is organic matter in its decomposed state in the soil and that formers are always trying to supplement the dung supply or, in special cases, substitute some other form of organic manuring more suited to their soil conditions. "The need of cultivated soil for organic matter is not met from within the cycle of normal farming practice."

204. Hahn, U.: The use of compost from domestic wastes in the Forestry Administration of the Netherlands. IRGR (1) 18, May 1958 (1955 - German).

(see IRGR)

205. Harrar, A.: Humus, soil life, and fertility. IRGR (5) 19, Mar. 1959 (1957).

(see IRGR)

206. Haworth, John: Composting scheme in Kuching. WHO Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 4pp., Oct. 15 - Nov. 1, 1956.

Composting experiments with refuse and night soil were started in 1952 at Kuching, Sarawak, Straits Settlement. The town refuse has a high percentage of vegetable matter, no scrap worth salvaging, and a minor percentage of uncompostable material. Refuse and sludge were used in a proportion of 1 ton to 180 gal initially with

206. an additional 90 gal of night soil added after 7-10 days. Composting was done in concrete floor bays by laying one foot of refuse, saturating it with night soil, and repeating the layers until the heap was 6 ft high. After the first turning in 7-10 days, the additional night soil was added. Thereafter, the heap was turned 3-4 times, then allowed to mature. Total composting and curing time was 3 to 3-1/2 months. One ton of refuse treated with night soil yielded 808 lb of sieved compost. A vibrating screen was used to sieve compost, oversize being returned to the compost heaps. In 1954 the compost had a C/N of 7.5 with N of 1.2% (dry weight) and volatile solids (loss on ignition) of 31.5%. P_2O_5 was 1.2% and K_2O was 1.4%. Some cost data are given.

207. Herrmann, W.: The meeting of der Arbeitsgemeinschaft für kommunale Abfallwirtschaft (AkA), July 4-6, 1957 (summary). IRGR (3) 1-3, Oct. 1958 (1957 - German).

(see IRGR; also AkA)

208. Horstmann, O.: Experiences at the Heidelberg composting plant. IRGR (4) 17-18, Feb. 1959 (1957 - German)

(see IRGR)

The Albert Howard Fnd. and the Soil Assn.

(See 264)

209. Hurter, H.: A new Swiss refuse disposal procedure. IRGR (4) 1-4, Feb. 1959.

(see IRGR)

210. Hyde, C. G.: The thermophilic digestion of municipal garbage and sewage sludge, with analogies. Sew. Wks. J. 4 (6) 993-1001 Nov. 1932.

Garbage and sewage sludge are defined and typical analyses are presented as well as quantities produced. Garbage from large cities averages 180 lb/cap/yr, equivalent to 5.4 cu ft/cap/yr, with a moisture content of 75.5%. Three types of sludge are described: raw (95% moisture), activated (98% moisture), and digested (91.5% moisture). Sludge productions in lb dry solids/1000 pop/day and cu ft/1000 pop/day are: Raw 108 and 33; activated 225 and 181; and digested 69 and 6.7. On dry weight basis raw garbage and raw sludge have the following analyses: Volatile solids 81.2% and 73.0%, ether soluble matter 14.5% and 7.5%; N 4.3% and 3.0%; P_2O_5 3.7% and 2.85; potash (K_2O) 2.2% and 0.6%; and ash 22.1% and 30.6%.

Thermophilic (high temperature) digestion of either constituent should be more rapid than mesophilic digestion (at ordinary temperatures). Thermophiles grow best at 130-170°F while facultative thermophiles grow from 68 to 140°F.

210. The Beccari process of garbage decomposition is described. Digestion occurs in closed cells for a week, then vents are opened for the remainder of the 35 days required. Average temperature for the entire time is 130°F, developed by thermogenic forms of organisms. Maximum temperatures are 140 to 160°F. Final moisture is 10 to 15% and the final weight is only 10 to 20% of that of the raw garbage.

Anaerobic digestion of liquid sludge under thermophilic conditions can be accomplished in 10 to 12 days instead of the 30 days normally required for mesophilic digestion. Sludge moisture is reduced to 91% and 1/3 of the original sludge weight remains. Seeding is reported to be necessary in both garbage and sludge digestion. N-P-K values of the resulting humus are reported as:

	Digested Garbage (Beccari process)	Digested Sludge
Nitrogen (N)	2.5%	2.1%
Phosphates (P_2O_5)	2.9%	1.4%
Potassium (K_2O)	1.2%	0.6%

Both types of humus are reported to be "valuable fertilizers". Mention was made of 5 small Beccari-type plants in the U. S., perhaps 80 world-wide. Thermophilic sludge digestion is still in the experimental stage.

211. (IRGR) International Research Group on Refuse Disposal: Internationale Arbeitsgemeinschaft für Müllforschung (IAM); Groupe International de Recherches sur les Ordures Menageres (GIROM): Information Bulletins published in French and German (available from: IAM, Physikstrasse 5, Zürich 7/44, Switzerland) and in English (available from: Public Health Service, Communicable Disease Center, P. O. Box 769, Savannah, Georgia).

Issues to date:

Info. Bull. No.	French and German version	English version
1	November 1956	May 1958
2	April 1957	October 1958
3	October 1957	October 1958
4	March 1958	February 1959
5	August 1958	March 1959
6	January 1959	(Pending)

211. (Articles printed in toto, summary, or abstract in above bulletins are listed alphabetically by senior author in the bibliography. Abstracts are not repeated herein. Only the English translation of foreign-language article title is given. Date and pagination refer to the English version. Date and language of original article are given parenthetically, where available.)

The IRGR was formed in June 1956 at a meeting in Scheveningen, the Netherlands, Prof. Dr. O. Jaag is President and Dr. R. Braun is Secretary (both at the above Zürich address). Functions in brief, are:

1. To publish a periodic information bulletin for interested persons in various nations (in English, German, and French).

2. To function as an information bureau.

3. To act as a clearing house for exchange of reprints.

4. To draw up general progress reports of scientific studies on domestic wastes.

The bulletins are particularly valuable to those interested in composting and utilization of composts.

212. Ishibashi, T. and Iwato, T.: Summary information on the collection, disposal and utilization of organic wastes in Japan. WHO Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 21 pp. Oct. 14 - Nov. 1, 1956.

(Only the composting activities are covered in this abstract).

About 28,500 metric tons of refuse and garbage are composted per month in Japan; this is 8.5% of the total from 356 cities. Farmers also use a primitive composting method for grass and night soil. Research in composting is being conducted at Kobe City and by the Kanagawa Prefectural Hygienic Laboratory. A plant is being constructed at Kobe City and is expected to be in operation by August 1956. Capacity of the plant is 20 tons/day of garbage (refuse) and 10 tons/day of night soil. The composter is a three-storied unit with each chamber having two horizontal passageways (Ed. note: This is presumably the T. A. Crane type, see Abs. Nos. 63 and 107). Provision is made for 48-hour retention in the digester and the plant cost $35,000 excluding the grinder (see also 155).

213. Jaag, O.: The removal and rational use of household refuse; an important task in our time, and the necessity for adequate planning of pertinent research. Rev. Suisse Hydrol. 17, 378-382, 1955. Water Poll. Abs. 31, 635, Mar. 1958.

"The author discusses the disposal of household refuse by incineration and composting. In Switzerland there is little demand for

213. humus from the composting process since few soils are deficient in humus or acids. Incineration is used for disposal of refuse in areas of large population and composting is used in rural communities. Methods of disposal of refuse in other countries are reviewed briefly and the necessity for international cooperation in research on this problem is emphasized." (WPA)

214. Jaag, O.: The necessity for standard methods of analysis and evaluation of refuse compost. IRGR (1) 3-4, May 1958 (June 1956).

(see IRGR)

215. Jaag, O.: Present problems of refuse composting. IRGR (5) 18-19, Mar. 1959 (Oct. 1957).

(see IRGR)

216. Jaag, O.; Walker, H.; Allenspach, H.; and Braun, R.: Refuse utilization. IRGR (5) 19, Mar. 1959 (June 1958).

(see IRGR)

217. Jackson, F. K. and Wad, Y. D.: The sanitary disposal and agricultural utilization of habitation wastes by the Indore process. Indian Medical Gazette 69:93-100, Feb. 1934.

Sanitary disposal of refuse and human wastes is still not widely practiced in India and open dumping or scattering of refuse is the rule. Only a few cities have a water-borne sewage system and in those the sludge is difficult to handle. Night soil is either applied directly to land or allowed to rot in trenches with resulting odors and flies.

As early as 1893 Dr. Voelcker said 'the spread of a good system of utilizing human and household refuse, street sweepings, etc., on the land (is) a most important factor in the improvement of Indian agriculture'. The "ideal disposal of habitation wastes is to send them back to the land as organic manure".

In the early 30's a process was developed at Indore and a revised process is now in full operation. Features are: 1) immediate treatment of refuse and night soil in trenches 2 ft deep and 15 ft broad; 2) addition of half-rotted compost as a starter; 3) lightly spreading with rakes into thin layers; 4) development of temperatures usually above 50°C (never below 45°C) persisting up to the third turn, thus killing pathogens and fly larvae; 5) turning three times with a digging fork to restore aeration and intense microbial action; 6) the replenishment of moisture at turning, if needed. Advantages of the Indore process are said to be: low costs, profit from sale of manure, simple construction, small land area, prevention of odors and fly breeding, an all-weather operation, no need for skilled supervision, cleanliness, short

217. composting period, and applicability to both large and small cities. Operating and cost data are given. Data show higher crop yields than with farm compost.

218. Jackson, F. K.; Wad, Y. D.; Panse, V. G.: The supply of humus to soils. Inst. of Plant Industry (Indore, Central India) Bull. No. 2, 10pp, 1934. (Repr. from: The Empire Cotton Growing Review, Apr. 1934)

Studies of making composts from farm wastes have led to scientific economic practice. Practicability of conserving initial nitrogen and of making up slight deficiencies by natural fixation during decomposition has been demonstrated in the Indore process. Essentials for practical efficient composting are: (1) Aerobic conditions, (2) optimum temperature ranges, (3) cheapness, simplicity and flexibility, (4) cleanliness and sanitation. Composting by the Indore process is claimed to meet these needs. The process is in wide use in India.

In wet areas, farm wastes are collected mainly in the dry months and used over the year for cattle bedding. Composting is with these wastes plus dung and ashes. Heaps are turned 3 times with the growing of legumes between turns. The latter hastens the rotting and within 4 months a compost is produced with 0.9-1.25% N, up to 3% potash, and 0.5% phosphate. Up to 99.5% passes a 3 x 3 mesh sieve and 97% passes a 6 x 6 mesh sieve. Loss in nitrogen is about 42% but the percentage of N increases from about 0.78 to 1.04. Four inches of rain penetrates about 6 inches into the heap, raising the moisture to 75%. Further rain soaks no deeper unless a turn is given. Decomposition accelerates surprisingly following timely turnings.

In dry areas, irrigation canals and use of trenches to conserve water are used. Composting such wastes as cotton and sorghum stalks or sugar-cane trash is slow because of low N content and poor physical texture. Legumes, such as "sann" hemp, grown on the heaps, add nitrogen by fixation. Though the plants grow only a foot high, they develop a dense mass of roots crowded with nodules. "Sann" was better than other legumes and was best planted after the first turn.

Humus should not be considered a means of replenishing soil nitrogen, it should be little different from natural organic matter. Humic composts "are intended to maintain a healthy physical condition in soil so ensuring an optimum environment for physico-chemical and micro-organic activities congenial to crop growth". An "experiment at Indore showed that by merely preserving an open texture in the soil, yields of Indian cottons could be doubled and of American varieties, trebled".

Two appendices give detailed techniques for preparing compost from mixed vegetative wastes, dung, field soil, and wood or vegetable

218. ashes. The difference is: (1) windrow method is used where ample rain provides moisture (2) trench method is used where watering is done from an irrigation canal. Method (1) involves windrows 8 ft wide and 3 ft high and of suitable length. First turn is made when rain has soaked the outer 6-9 inches; second turn after about a month; third turn about a month later. A fourth turn may be necessary if the materials are not well-rotted. Total time is about 4 months. Method (2) involves trenches 2 ft deep and 15 ft wide. Materials are the same except in a new trench it is recommended that a "starter" of old farmyard manure be added. The trench is charged to 6 inches above ground except that one end is left open for a length of about 10 feet to permit turning. Two waterings are given, the "starter" scattered over the charge, and the first turning is made. Two more soakings are followed by a second turning and this is repeated for the third turning. The last turning is to the outside of the trench in a 3 ft x 10 ft windrow. Compost is ready for application about a month later.

219. Kaibuchi, Yonosuke: The 6th report on the high rate composting of organic wastes (refuse and night soil) in Kobe City. City of Kobe, Japan Mimeo. 17pp, Apr. 1958.

The City of Kobe, with help of WHO and the Ministry of Public Health and Welfare of Japan, completed a prototype composting plant in August, 1956 and a curing bin in March, 1957. The plant consists of: raw refuse sorting, grinding in a hammermill, night soil mixing, mixed materials storage bin and table feeder, composter of modified Earp-Thomas design, curing bin. Design capacity was 25 tons of refuse at 35% moisture and 10 tons of digested sludge from night soil at 95% moisture per day. Difficulties have been experienced in achieving the rated capacity.

The hammermill was designed for 7 tons of refuse/hr but had an actual capacity of only 2-3 tons per hour because of non-uniform and discontinuous feed by the sorting belt and extremely rapid wear of the hammer plates and blades, resulting in outlet clogging. The storage bin and table feeder above the composter permits arching of the material, preventing it from falling onto the feeder table. These are now being by-passed by direct hand feeding of the digester. The digester has four floors with plows operated from a central vertical shaft turning at 0.2 rpm. High torque is required to move the material with the plows resulting in considerable breakage. The horizontal movement of materials to drop from deck to deck did not go well. Plows were changed to the screw type and a special turning device was developed to move the material horizontally on each deck. To secure 2-day retention in the digester, a horizontal damper was installed on each deck. The capacity is now 4 tons of compost/day, still far short of the expected capacity. Further plant revisions are planned.

Temperatures increase from 22° to 31°C in the first deck, average

219. 50°C in the second deck, but decline to less than 30°C in the third deck. Upon curing, the temperatures rise to higher values (60-63°C) than in the composter. Moisture decreases to about 47% from the digester and 40% from the curing bin. Ash content increases from 57% to about 64%, finally. (Ed. note: Considerable discussion is given of capital and operating costs based on the so-called final revised plant which has not yet been constructed. The cost data are therefore not believed to be realistic).

220. Karim, A. and Chowdhury, M. U.: Decomposition of organic wastes. Soil Sci. 85, 51-4, Jan. 1958. PHEA 38(7) S65, July 1958.

"The decomposition of city wastes comprising street sweepings, fish-market and slaughter-house garbage, and household refuse collected from the Dacca (East Pakistan) city area was studied under various controlled conditions. The effects of the different treatments and aeration conditions on degree of decomposition and on constituents thereof were investigated, and the loss of total dry matter, fats and waxes, furfural, cellulose, lignin, and protein at stipulated intervals was determined.

"The effects of the different treatments on degree of decomposition did not differ significantly. Considering the losses of dry matter and protein found, it was concluded that the compost should be made under aerobic conditions, with inoculum treatment, with a period of 90 days for decomposition. In the decomposition lignin represented the smallest loss, fats and waxes the greatest, and cellulose and furfural were an intermediate loss.

"Wastes composted for a period of 90 days with only an inoculum treatment formed a product virtually identical in manurial efficiency with horse manure in respect to energy-yielding materials and very superior in respect to total nitrogen content. City waste composts contained 10 times as much nitrogen and potassium and three times as much phosphorus as cow manure." (Authors)

221. Kefford, R. O.: Report on the conservation of city waste. J. Aust. Inst. Agric. Sci. 21, 152-162, 1955. Biol. Abs. 31, 2652, 1957. Water Poll. Abs. 31, 637, Mar. 1958.

"Garbage has been composted successfully, with or without addition of sewage sludge, in many parts of the world. Composting is not, however, considered an economic method for disposal of garbage in Victoria, Australia, as the capital costs of installation are high, a large labor force is required, and the present method of tipping and covering garbage has proved satisfactory. There are still adequate sites for tipping in the Melbourne Metropolitan area. Present methods of disposal of sewage are economical, and health regulations prevent the sale of sludge. The sale of compost prepared from garbage and sewage sludge is considered inadvisable because

221. of the difficulty of supervising the process to ensure that all portions of the compost heap reach temperatures sufficiently high to destroy all pathogenic organisms and parasitic ova." (WPA)

222. Keilling, J.: The treatment and use of household refuse in France. Tech. de l'Eau, 10 (115) 31-2, 1956. Water Poll. Abs. 31, 857, Apr. 1958.

"The treatment and use as compost of household refuse in Paris, Bordeaux and Mediterranean regions of France is reviewed briefly and the action of humus on the soil is discussed." (WPA)

223. Kim, Yeon Choo: A report concerning organic wastes in Korea. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 9pp, Oct. 14 - Nov. 1, 1956.

Korean farmers have little chemical fertilizers and compost and night soil represent the main fertilizer used. A large-scale organic fertilizer plant has only recently been developed. Composting of garbage with human and animal excreta and grasses has been practiced for years by crude methods. A large-scale Earp-Thomas type plant, operated by the Tong Yang Organic Fertilizer Co., treats night soil and rubbish at Seoul. This is described in another paper by Kim.

224. Kim, Yeon Choo: A report on Earp-Thomas compost plant, Seoul, Republic of Korea. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 10pp. Oct 14 - Nov. 1, 1956.

An Earp-Thomas process composting plant of about 75 metric tons/day capacity (refuse and night soil) was privately built by the Tong Yang Organic Fertilizer Co. in Seoul at a cost of $600,000. It was placed in operation May 20, 1956. Steps in the process are: refuse (20% garbage, 80% trash) is loaded by hand to a primary conveyor (3ft x 25 ft) and sorted by hand; grinding (Mitts-Merrill 30-in 75 HP); night soil addition and mixing; addition of bacterial culture; digestion (19 ft diam. x 25 ft high, 8-deck digester for 24-hr composting); three-compartment curing tank; addition of second bacterial culture with mixing in a GOTO rotary mixer; screening (1/4-mesh vibrating screen) with grinding of tailings in a small Japanese grinder; bagging (50 kg rice-straw bags).

Initial trials met with equipment troubles and flies and odors. Some modifications of the plant were made, including the change to screw conveyors but the present plant is unsuited for use with city refuse. The company has had to purchase materials to be composted and these consisted of peat 15%, night soil 55%, beer dreg wastes 15%, and bean curd wastes 15%. Some garbage from the public markets is used. About 70 tons of fertilizer has been produced,

224. largely from a mixture of equal parts of bean curd wastes, night soil, beer dreg wastes, soil, and peat. No arrangement was made with city officials to donate garbage and night soil to the private concern. (Ed. note: Later word has been received that this plant has "failed" although the accuracy of this report is unknown.)

225. Klein, George, Menomonee Falls, Wis. U. S. Patent 2,750,269: Process of making an organic compost. Filed: August 11, 1952; Pat. issued: June 12, 1956; no dwgs.

This is a windrow composting process, primarily for "cow and like manure", with additions, to provide a "fertilizer and soil conditioner..."rich in nitrogen phosphorous, potash, and other organic matter, but which will also effectively activate and revitalize soil". The resulting material is claimed to be "a loam-like manure compost of humus which will not harm (burn) growing plants, and which can be used by farmers, gardeners, and florists, both professional and amateur, to activate their own compost or manure piles". For 1 ton of compost, the following are used: 1500 lbs of manure, 100 lbs straw, 100 lbs wood shavings, 100 lbs corn cobs, 50 lbs chopped alfalfa, 60 lbs rock phosphate, and 50 lbs crushed lime. Windrows of thoroughly mixed materials are preferably 300-400 ft long, 4-5 ft wide, and 3-4 ft deep at the crown. Windrows are turned and thoroughly agitated when the temperature reaches 140°F or above, suggested means being by using a manure spreader. This results in turning about once per week and the total time required is about one month. The material is then "stockpiled for about six months, or until the material is very brittle and practically decomposed". After this, the material is screened and bagged in 2 to 100-lb bags of "Pliofilm and polytex bag to reduce moisture loss". Corn cobs and alfalfa may be added during composting to reduce moisture.

226. Klenk, Ernst: The use of refuse compost in viniculture. IRGR (2) 4-8, Oct. 1958 (German)

(see IRGR)

227. Kodama, Takeshi; Muto, Nobuo; and Toya, Yasunori (I) Doi, Sei; Uemura, Susumu; and Takahashi, Kazuo (II): High rate composting of city wastes: I. Laboratory tests, II. Pilot plant tests. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 27pp, Oct. 14 - Nov. 1, 1956.

I. Laboratory composting tests of ground refuse, night soil (mostly faeces), and manure were made at Yokohama in 10-l. pots fitted with wire netting and aerated at 1 l/min. Temperatures reached 50°C in 24 hours and gradually started to fall after 3 days. After 5-7 days a dark, soil-smelling compost was produced but not all fibrous tissues were decomposed. Seeding with compost gave 2-3° higher temperatures. Seeding with a special bacterial culture produced no

227. measurable improvement. Three special seeding cultures were compared to manure by bacteria isolations into 11 groups and there seemed to be no basic differences.

II. Pilot plant studies at Yokohama were conducted September 1955 to May 1956 with city refuse and night soil. Steps were: manual separation of refuse, shredding, addition of night soil, digesting, curing, shredding, and screening. Refuse contained about 50% paper and 30% sand and soil. Tests indicate that some ballistic separation of compostables from inorganics may be obtained by the horizontal type hammermill. About 70% refuse, 30% night soil permitted a mixture with less than 65% moisture content for composting. Filtration and absorption of night soil by refuse was tested and showed that dilute night soil was readily filtered but thick night soil formed a solids layer unduly prolonging filtration. Filtering time for various thicknesses (40 to 80 cm) did not vary greatly. About 45-55% of the initial weight of the refuse was absorbed. Night soil improves refuse for composting but adding an excess (to the point of leaching) is undesirable as balls are formed in the digester.

The digester was a 1.85 m diam. x 44 m long, insulated, rotating drum (1 rev/16 min or 1 rev/5.5 min). Pre-heated air was blown in the outlet end. Both continuous (manual) or batch feeding were used and digestion time was 4-5 days. Temperatures at 65% moisture content reached 60-65°C in 2-4 days then gradually declined. Upon piling afterwards both long and short periods of high temperature occurred (in the graph shown, the temperature on curing was 60°C or above for 8 days).

Because all of the night soil could not be mixed with refuse (too wet), several tests were made to concentrate or treat the seepage from addition of excess night soil to refuse. This seepage is dark-colored and has a BOD of about 3000 ppm and COD of about 1500 ppm. Tests involved chemical coagulation, sand filtration, and aerobic decomposition of the seepage liquid. Conclusion was: "At this stage, it would be wiser to consider the addition of night soil as a means of moisture and CN regulation rather than night soil treatment".

228. Kortleven, Jac: Tests with city garbage compost. I. Influence of garbage compost on vegetation. Verslag. Landbouwk. Onderzoek 62.12, 243, 1956. Chem. Abs. 51, 11635 Aug. 10, 1957. PHEA 38 (4) GR-1 Apr. 1958.

"Fertilization of sandy and valley soils with VAM-process garbage compost gave average crop yield increases of 5%. The effect of compost is greater in the year following application. In comparison with effects of mineral fertilizer, such increases are uneconomical; however, the possibility of progressive soil improvement and increased crop security must be considered. In mineral-deficient soils, compost may raise yields several hundred percent. With

228. compensation for mineral elements in the compost, the specific effect of compost is 3% or less. The greatest effects are ascribed to Ca and Mg. N and P are poorly assimilated. Processing methods affect yield and effect of compost. In the Wijster system, 70% of the organic matter is lost, without improvement in quality of the residue. In the Dano process, the loss is only 15-20%, and in the grinding system, 10-12%. Unfermented compost binds N in the soil, causing reduced yields if applied in spring, but preventing leaching of N if applied in the fall." (PHEA)

229. Krige, P. R.: The future sewage purification plant as an all-important link between producer and consumer of food. Inst. of Sew. Purif. (So. African Branch) Mimeo. 13pp. Sept. 21, 1956.

"The author indicates how more use should be made of the sewer as a cheap transport medium for certain wastes which are at present carried by surface vehicles at considerable cost. The Transfer Station is an indispensible item in the waste handling programme of the modern city in order to economize on long distance haulage. Mechanically aided sorting of all waste materials at the transfer station results in an organic component which could then be consigned to the sewer and an inorganic component which is returned to industry for reconditioning. Fine ash is the one ingredient which is likely to constitute a problem.

"The author strongly advocates the establishment of Waste Treatment Depots, preceded by transfer stations in the case of large communities. The main sewer terminates at the waste treatment depot, which should be in close proximity to the city and where all solid wastes are also delivered. Sewage plant will be limited to sedimentation units and biological filtration. All sewage solids (raw sludge, screenings, grit and scum) are then combined with dry organic wastes in a suitable plant to produce biologically stabilized material in the shortest possible time. Mechanical sludge thickening may be necessary.

"A Regional Waste Treatment Board is suggested for densely populated areas, such as the Witwatersrand and siting of waste treatment depots should be on a regional and topographical basis without reference to municipal boundaries. Waste utilization in South Africa is much overdue as a link between consumer and producer of food."

The solid wastes processing advocated is composting in a "suitable mechanical plant in order to effect aerobic biological stabilization in the shortest possible time" using sorted and ground refuse and raw wet solids from the sewage treatment plant. Sludge thickening to 90% moisture may be required where dry refuse is used or to 80% moisture where sewers carry both the sewage solids and the ground organic portion of the refuse. Complete removal of solids from the liquid is proposed in one sedimentation tank, such as the Dortmund type, including grit, sludge, and scum--rather than

229. having separate grit and screening devices. Night soil can be composted equally as well with refuse in communities having no sewer systems. Both solids (compost) and liquid (purified sewage effluent) are in short supply in South Africa and "will assume great importance in the future development of our country, but perhaps the accent should fall on the urgent need for humus". (Author)

230. Krigé, R. P. (1); Teletzke, G. H. (2); and Wiley, John S. (3): Discussions of: Liquid content of garbage and refuse. ASCE Proc. Paper 1614, J. of San. Eng. Div. 84 (SA2) 7-11, Apr. 1958.

(See 142 for initial paper by Wiley).

(1) Mr. Krige of Pretoria, S. Africa agrees with the author in distinguishing between moisture (water) content and 'liquid content'. Lipids, if not already fluid, can be assumed with reasonable safety to be liquid at the thermophilic temperatures of an active compost system and they should be included with the true moisture, as proposed. He points out, however, that lipids are "completely removed by composting" though they may help to exclude air initially. Anaerobic decomposition, as in sludge digestion, does not effect lipids which cause scum troubles. The discussor points out the difficulty of running the prescribed tests in actual operating practice.

(2) Prof. Teletzke of Purdue University, in discussing the paper points out that "not all lipids are liquid at the composting temperature" and probably the analyses for lipids should include only the "liquid lipids" in calculating the liquid content.

(3) Mr. Wiley in his closure offered rebuttal to (2) in that lipids are "mixtures of glyceryl esters of the fatty acids". A table of melting and solidifying temperatures for various oils and fats is presented, showing that all are liquid at 60°C (140°F) or less, a readily attainable temperature in composting. It is granted that some waxes are probably not in liquid form but only small amounts would be present in garbage or refuse.

The discussor agrees with Mr. Krige that lipids are readily oxidized, about 75% decomposition being found at Savannah. Also lipids have a high food energy value and accounted for about 75% of the total heat production in composting refuse. The three analyses required to obtain liquid content (moisture, ash, and lipids) are far simpler tests than those for carbon and nitrogen. They tell a lot about the physical condition of the materials for composting without requiring complete analysis.

231. Krogh, K. P. B. P. 746,353: Drum sieve for treatment of refuse. J. Sci. Food and Agr. 8, 112 Mar. 1957. PHEA 37(10) GR-6 Oct. 1957.

231. Patent: "The refuse enters the rotating drum after tramp iron and cloth have been removed. Fine waste is rapidly sieved out and falls into a hopper. Paper comes to lie on top of the remaining waste and is moistened by a water spray while the remaining underlying waste is kept dry. A second chamber contained rotating arms which disintegrate paper and waste which fall through the sieve. The non-comminutable remainder passes out the far end of the drum." (PHEA)

232. Lesaca, Reynaldo M.: Some problems associated with organic wastes in Manila. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 11pp, Oct. 14 - Nov. 1, 1956.

(This report considers administrative, financial, public health, and technical problems of refuse disposal in Manila. Only the composting discussion is abstracted here.)

Two experiments were recently completed in composting refuse in low stacks on the ground. Both showed temperatures of 60-70°C or higher in the mass for 18-20 days. Resulting screened compost was dark earthy in appearance and had no odor. While N, P, and K values were not impressive, utilization of night soil should give higher values. The writer cautions about over-estimating the value of compost and the need for an assured market. Data needed include operation and maintenance costs, need for seeding compost piles, C/N ratio of finished compost, and acceptability for use in gardens and farms.

233. Ludwig, Gordon W.: Status of composting in the United States and Canada. Air Poll. Fnd. Report No. 3, pp 37-38, Jan. 1955.

National interest in composting is being expressed because of need for a more economical method of garbage and refuse disposal. Those developing composting processes in the U. S. are: equipment manufacturers, some individuals, universities and research groups, and health groups. Two distinct methods have been developed: Mechanical, high-rate, continuous flow processes, and outdoor windrow composting. The Earp-Thomas composter is not readily adapted to changing wastes. The Frazer Corp. plant at Bay Shore, L. I. had a shredder that could not handle garbage and the unit is being used to compost manure, tankage, sawdust, and other refuse materials. T. A. Crane of Toronto has developed two composting machines: The first was not adjustable to the type of wastes, the other is mechanically superior and capable of rapid expansion to meet varying capacity demands. The American Composter Co., Lansing, Michigan has developed a unit which has several difficulties and is very slow acting.

In 1953 Michigan State College undertook an extensive investigation and testing program on composting with detailed laboratory research and testing of a high-rate composter of Earp-Thomas design. Similar

233. work is being conducted by the Savannah Laboratories of CDC, Public Health Service in determining the fundamentals of high-rate composting. Most other studies are by trial and error but more knowledge is being gradually acquired. The author expresses a bright outlook for composting.

In the following discussion (p. 39) composting elicited many comments. Concern was expressed about a market for the compost as there is no shortage of organic fertilizers in some areas. A private company at Oakland, California experienced a cost of about $32/ton for producing compost. Value may be from none to $10/ton. Composting might be used as a volume reduction method (attaining 70 to 80% reduction) but landfilling is a less expensive means of accomplishing refuse compaction, although slower.

234. Maier, Paul P.; Williams, Edward R.; and Mallison, George F.: Grinding stations to minimize refuse hauling costs. Manuscript 8 pp, Feb. 1959.

A pilot, refuse grinding plant was operated 6 months at the City of Chandler, Arizona by the Public Health Service. In 159 days of operation 8.8 tons/day of refuse were treated. Cost data were carefully maintained. It was then estimated that a 100 ton/day plant (serving about 10,000 population) would have a capital cost of $1,480/ton of rated capacity and yearly operating cost (including amortization) of $1.55. Salvage operations should result in a return of about $2.30/ton of refuse which would more than pay for the grinding plant operation. In addition the volume of refuse would be reduced and haul costs would be greatly reduced by using a large tractor-trailer instead of collection trucks to haul to the disposal or treatment site. For an average haul of 12 miles (round trip) savings in haul are estimated at $40,000-$50,000 per year. Total savings per year, including haul savings, salvage sales, and retirement of some of the collection trucks, would amount to $115,000 to $125,000. If a sanitary landfill is used, the capacity of the area would be about doubled. (Ed. note: If composting is used, the refuse would be already sorted and ground, ready for adding moisture and composting.)

235. Martin-Leake, H.: How can we use our sewage and our refuse? Albert Howard Fnd. of Organic Husbandry, Publ. No. 2, 24pp, 1949.

A case for returning wastes to the soil into the natural cycle is presented. Present methods of refuse and sewage disposal are discussed at length. Amounts of various types of nitrogen in the wastes are given and a model lay-out for fermentation of sludge and refuse is detailed. Also suggested are methods to reclaim food elements from sewage effluents by growing water hyacinth or similar plants. While composting of refuse-sludge mixtures in rural areas and small towns is claimed to be simple it is admitted that management by a municipal authority in a metropolitan center presents problems at present.

236. Matsumoto, Junichiro: Some waste disposal problems in Japan, Part IV. Proposed refuse and night soil plant of Hiratsuka City, Kanaguwa Prefectare. WHO Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. p 10, Oct. 14 - Nov. 1, 1956.

The proposed plant will treat 3 tons of separately collected refuse and 5 tons of night soil per day. Refuse will be sorted, ground and conveyed to an absorption-filtration tank where night soil will be sprayed over it. The night soil filtrate will be diluted 18 to 20 times with water and treated in a trickling filter and final settling tank with effluent discharged to the river. The refuse-night soil mixture will be composted in a 2.3 m diameter x 9.0 m rotating drum digester for 4 days.

237. Mattingly, G. E. G.: The agricultural value of sewage sludge and town refuse. Proc. Inst. Civil Eng. (Brit.) 8,414, 1957. Abs.: Sew. and Ind. Wastes 30 (10) 1325, Oct. 1958.

"This paper summarizes the results of field experiments carried out in Great Britain since 1940. The effects of sewage sludges, pulverized town refuse, screened dust and composts of town refuses with sewage sludge, and straw with sewage sludge have been investigated. Details of the organic matter, nitrogen (total and inorganic) phosphorus, and potassium contents of the various wastes and composts used, are given.

"Sewage sludges supply slowly available nitrogen and phosphorus but very little potassium (most of which is lost in the sewage effluent). Composts of sewage sludge and straw are easier to handle than sewage sludge, which if above 50% moisture, is expensive to transport and difficult to work into the soil. Composts are potassium-deficient and do not supply as much nitrogen to the crop as sewage sludge, unless stored carefully for 6 to 12 months.

"Pulverized refuse and screened dust are both potassium-deficient and give much lower crop yields than equivalent amounts of farmyard manure. Composts of sewage sludge and town refuse are also low in potassium, but supply useful amounts of nitrogen to the crops. Organic manures made from town wastes generally give higher yields when used with inorganic fertilizers." (S & IW)

238. McCauley, Robert F.: The present status of composting and its air pollution aspects. J. Air Poll. Cont. Assn. 6, 233-7 (Feb. 1957); PHEA 88, AP 9-10 (Mar. 1958)

There is a general discussion of composting, including the many false claims and promises. Failures have resulted from mechanical difficulties and poor organization. Air pollution may come from garbage odors. With aerobic composting, the first stage gives off volatile acids. Large scale aerobic composting should be: conducted in a lightly inhabited area; or final drying should be conducted away from habitation, or have high stacks for disposing of

238. moisture, or recapture the moisture vapors. Odor problems can probably be met by: tall stacks, high-temperature burning, etc. but these devices limit the economic value of the composting process.

239. Municipal Engineering - Editorial: Composting cuts the cost of waste disposal. Mun.Eng. p 643, July 6, 1956.

Municipal authorities should consider combined disposal of sewage and refuse with composting of the putrescible material. Controlled tipping sites are not inexhaustible and many cities have inadequate sewage disposal plants. Use of refuse sludge in composting produces a balanced compost, more attractive to the farmer than sewage sludge. The compost at Edinburgh is enthusiastically received by the farmers.

240. Nesbitt, John B.: Composting of municipal refuse and some European composting operations. Penn. State Univ., Eng. Res. Bull. B-72, 26pp, May 1958.

This report includes visits to European composting plants and an investigation into the feasibility of composting municipal refuse in the U. S.

The author reviews the various factors fundamental to success in a composting operation as discussed by Gotaas in his WHO monograph, including: segregation and salvage, shredding, C/N values, moisture content, aeration, time required, and use of inocula. The ratio of available carbon to nitrogen at beginning and ending should be 30 and 20, respectively. Optimum moisture content is 40-60% by weight. Temperatures should rise to 55-70°C while the Dano Corp. believes maximum rates of decomposition occur at 45-50°C. Composting time required varied from 5 days to several months. Most of the successful European composting operations do not use special inocula. Plants visited were in Switzerland, The Netherlands, Scotland, Denmark, and the Isle of Jersey. Three methods were principally used: the Dano process (grinding and composting in a rotating steel cylinder), the VAM process (grinding and composting in windrows), and the Jersey process (composting mixed refuse-sewage sludge by mechanical aeration in a vertical silo and storage in windrows). Cost estimates are given for the 3 methods under U. S. conditions, as follows:

Estimated costs for U.S. plant handling 50 tons refuse/day (50,000 pop.)

Cost Item	Dano	VAM	Jersey
Total capital cost/ton capacity	$ 6,100	$ 8,840	$ 13,680
15-year amortization/yr (5%)	29,350	42,600	65,000
Yearly operation cost	23,300	32,250	60,670
Total yearly cost	$52,650	$74,850	$125,670
Cost per ton (oper. and amort.)	$2.88	$4.10	$6.88

240. No allowance is made for either value or cost of compost disposal. Allowance is made for disposal of non-compostables which amount to 20% in Europe but U. S. figures might be higher (about 50%).

The author concludes: "(1) Composting, although more popular in Europe than in the U. S., is not a widely used method for the disposal of municipal refuse. (2) Compost for use as an organic fertilizer is in great demand in Europe only in densely populated areas where the agricultural economy depends upon small farms producing in relatively sandy soil. (3) Of the composting operations visited in Europe, the Dano process appears to be the most economical for use in the U. S. (4) The use of special inocula is not an essential item in the success of a composting operation. (5) Further composting operations should be confined to small or medium-sized communities until ready markets are available."

241. Olds, Jerome: Commercial composting is striding ahead. Org. Gard. and Farm. 5(5) 51-4, May 1958.

The author contends that great strides are being made in composting wastes in the U. S. to produce organic fertilizers or soil conditioners. The newest plant uses the windrow method for composting combined refuse at Cincinnati. Organics, Inc., of which Brougham Nichols is President operates the plant producing an enriched compost under the trade name "Growz". Salvage and use of a magnetic pulley are practiced. Compost is enriched with coffee grounds, poultry feathers, and manure.

The plant in Sacramento (County) is described in which a Dano (biostabilizer) is used, operated by Dano of America, Inc., Dr. Ralph E. Scovel, President. Refuse is salvaged and treated in the rotating drum for 24 hours, being converted to "green compost" which is spread on "low-quality soil where the final stages of decomposition take place". The Earp-Thomas "continuous-flow digester" which retains the wastes for 24 hours is also mentioned.

The Yakima Chief Ranchers Inc., George Gannon, President, located at Mabton, Washington, composts hop vines, manure, slaughter-house blood, and paunch manure on a large scale. The heap (windrow) composting method is used and, if the process proves economical, the company hopes to take care of all garbage in the Yakima Valley. Composting activities in Southern Rhodesia and Isle of Jersey are also briefly mentioned.

242. Olds, Jerome: Fertilizer of the future. Ind. Wastes 3 (3) 67-71, May-June 1958.

Cheap sources of soil organic matter are needed and the raw materials for the organic fertilizers are wastes. The author discusses some unusual wastes as being of value, such as mesquite. wood wastes, and paper mill sludge. Various analyses and usefulness in composting

242. are given for 22 wastes and a table presents moisture, ash, N, P_2O_5 and K_2O contents of 39 wastes. The author concludes: "There is a great need as well as profit potential in making industrial waste products available for return to the soil. It is evident (from) the research already mentioned that the necessary processing, merchandising, and distribution methods can be successfully worked out. The result will mean increased profits, a solution to what may now be a waste 'headache', and the return of essential organic and mineral matter to the soil."

243. Olds, Jerome: Fertilizer from solid wastes. Industrial Wastes 3 (5) Technical information and data section, pp D-44-47, Sept. - Oct. 1958.

Dr. G. H. Collings, Clemson Agr. Coll., says the fertilizer industry may some day attempt to supply the farmer with cheap sources of organic matter. Such sources are necessary in almost every section of the U. S. Gardeners are increasingly desiring peat moss, dried manure, compost, and similar materials. The organic fertilizer must have raw materials available at little cost, available in all parts of the U. S. A number of wastes useful to the soil are discussed: buckwheat hulls, cocoa bean wastes, peanut shells, waste cellophane flakes, frit (glass compound), wood wastes, bark and chips, paper mill sludge. Analyses of 21 waste materials, primarily N-P-K contents are given.

244. Parrakova, E.: The most suitable method of refuse disposal for rural communities. IRGR (4) 20, Feb. 1959 (1956 - Czech).

(see IRGR)

245. Parrakova, E.: Making solid wastes safe by controlled refuse maturing and by composting. IRGR (4) 19-20, Feb. 1959 (1957 - Czech).

(see IRGR)

246. Peter, Ernst: Erfahrungen zur Aufbereitung von Müll in Gärzellen. (Experiences in the treatment of refuse in fermentation cells). Städtehygiene 6(12) 261-4, 1955.

The author derides the present-day trade interests in selling equipment and lack of consideration of biological treatment methods in the disposal of urban refuse, sludge, and suitable industrial wastes. Regarding refuse, he indicates that salvage market fluctuates and may not justify expenditure of high equipment costs in a plant. Also the emphasis on pulverization is bad because unpulverized refuse is better suited for biological treatment (Ed.?). He argues that pore space is thus reduced by half, reducing aeration. Unpulverized wastes reach 70-73°C in 2-4 days, pulverized wastes require 22-25 days to reach 70°C (Ed. ?). Fermentation cells are designed to receive 23 cu m of loose refuse. With unsorted, unground winter refuse (ash content of 56%), the temperature reached

246. 70° in 4 days and started slowly diminishing after 18 days. Optimum aerobic activity is reported to occur at 25-63°C. When the temperature reaches 70°C, there is speculation that a thermal kill may have occurred. Experiments were designed to test this. It was observed that wastes decomposing aerobically showed successive re-heating after each turning or aeration. This showed that neither a high temperature nor slow diminishment indicated that decomposition was ended. Intensity of aeration, rather than duration of aeration, appeared to be important. Single aeration is insufficient and the frequency can control the course of decomposition.

Ashes and unburned fuels are considered to be ballast in the case of biological treatment and they can reach 60% of the total refuse (weight). Ashes raise the alkalinity and, because they are fine, hinder air penetration, thus damaging biological activity. Lignite ashes, particularly, raise the boron content of refuse. At Baden-Baden, ashes are separated by screening into coarse, medium, and fine sizes.

Tests used in composting include nutrients for fertilization (N, P, and K) and a few trace elements (B, Cu, Mn, Mo, Zn). These are then wrongly compared for different countries and different seasons of the year. Time of decomposition is often disregarded. For sanitation, the destruction of pathogens, and parasites is necessary. In agriculture, the microbial population is at least as important as the nutrient content. Chemical analysis should serve to base the sale price of the compost, as neither physical nor bacterial properties can be calculated in monetary values.

Calculating costs of construction and operating compost works are confused. All costs, including interest and amortization should be included. Conversion of costs to different monetary standards is unusable without comparing wages of the workmen.

The author objects to fast composting (in 24 or 36 hours) as being inadequate. He deplores use of any sorting or shredding and argues that fermentation cells are economical (a cubic meter of compost requires only 2-1/2 hours' pay for a workman). It is claimed that good compost is produced in 4 to 8 weeks in a fermentation cell. Some comparative analyses are given.

247. Pfeiffer, E. E.: The compost manufacturers manual - The practice of large scale composting. The Pfeiffer Fnd. (Philadelphia) 137 pp, 1956.

(Ed. note: This manual is too lengthy to abstract so a simple listing of the Table of Contents is given) (see G4).

1.) A general review of the problem of composting; 2) raw materials useful for composting; 3) the evaluation of raw material analyses; 4) how to understand and master successful composting. Demonstration

247. and research plan; 5) the calculation of the compost mixture formula; 6) the bacterial treatment; 7) observation of piles and correction of abnormal fermentation; 8) the taking of samples from fermentation piles and laboratory tests; 9) analytical details; 10) the calculation of enriched composts; 11) the addition of nitrogen fertilizers to composts; 12) how moist is moist?; 13) date of application and fertilizer value; 14) fertilizer cost and efficiency from the farmer's point of view; 15) field and laboratory trials and results; 16) availability of nitrogen, phosphate and potash in soils due to application of microorganisms; 17) the planning, engineering and operation of a composting plant; Appendix: Reports; Bibliography; Index.

248. Pfeiffer, E. E.: Instructions for the manufacture of compost from urban and industrial refuse. IRGR (4) 20, Feb. 1959 (1957 - German).

(see IRGR) (see 247 for English version of a similar manual)

249. Pierson, N. A. U. S. Patent 2,797,051: Cylindrical drum mill with plurality of pivotally mounted hammers on inner periphery. Filed - Feb. 18, 1955; Patent issued June 25, 1957. 4 figs. (Assignor to Naturizer Co., Norman, Oklahoma).

This is a "pulverator" particularly for reducing the aggregate size of municipal refuse. The drum rotates nearly horizontally while the refuse passes through lengthwise. Pivoted, saw-tooth edge, hammers are arranged in four spiral rows lengthwise of the drum interior. Hammers fall as the drum rotates slowly (about 11 rpm). The hammers are slightly longer than the drum radius and therefore overlap, but they are alternated so as not to strike each other. Two driving rollers hold and turn the drum on one side, two idler rollers support the other, opposite the driving rollers. Hammers are fastened to a bracket by means of a bolt. There is a restricted inlet end (smaller diameter than the drum) and an outlet baffle ring over which the ground refuse tumbles. Only one hammer strikes at a time because of the spiral arrangement of each row of hammers (two adjacent hammers striking in order are always greater than 90° apart). Grinding is by striking and masticating.

250. Pierson, N. A. U. S. Patent 2,823,106: Process of fermenting municipal refuse disposal. Filed: Sept. 1, 1954; Issued: Feb. 11, 1958, 5 figs. (Assignor to Naturizer Co., Norman, Oklahoma).

This is an out-door windrow composting process involving first a 12 to 24-hour anaerobic decomposition and second an aerobic decomposition with one turning for a total (aerobic) composting time of 14 to 27 days. Initially the unsorted refuse is windrowed and the windrow is then flattened with a bulldozer or similar machine to a depth of one to three feet, after being sprayed with "a lignin digesting bacteria" (provided in dried steer manure). In 12 to 24

250. hours the temperature of the refuse, wetted to 60-80% moisture with water or sewage sludge, will reach about 55°C. The windrow is then turned and aerated, as with a bulldozer, and loosely stacked for aerobic decomposition, at which time moisture drops to about 40%. Two stacks may be combined to give a height (loose) of about 6 feet. The "mold" within the stacks reaches peak activity in 5 or 6 days when the windrow is again turned and mixed as before. One or two wettings may be necessary to maintain about 40% moisture. Refuse is retained in the new piles from 9 to 21 days, depending on climatic conditions, or until it "attains a brown earthy appearance and texture, and gives off a pleasing fragrance". Finished compost is screened in a rotary drum screen with two sizes of openings, one fine which discharges material for bagging, one coarser which are called "first tailings" and may be applied to land or re-treated. Coarse material (about 3%) is discarded. More frequent turning is needed when digested sewage sludge is added to refuse.

251. Prat, M.: Garbage disposal (Destruction des ordures menageres). La Technique Sanitaire et Municipale, 52, 34-41, Feb. 1957. PHEA 38 (4) GR-2, Apr. 1958.

"Problems arising from increasing amounts of garbage for disposal by incineration led the city engineer of Toulouse to investigate accelerated composting. The present system of disposal is described with advantages including hygienic removal, production of heat for transformation to electric power, etc. This system does not allow for agricultural use of clean compost which, when mixed with soil, can produce better plant growth. The systems of composting are reviewed and some experiments showing good results in 9 days are tabulated. The Bonamici system is used in which only magnetizable materials are removed from a moving band carrying garbage to portable cellules. The remainder of the solid matter is pulverized. Catalytic agents are added at the beginning of the fermentation. A cost sheet is added to show the theoretical practicality of the system." (PHEA)

Public Health Service - Amer. Pub. Wks. Assn.

(see 149)

Public Health Service

(see 283)

252. Rawn, A. M.: Planned refuse disposal. Co. San. Dists. of Los Angeles Co. Report, 117pp. Sept. 1955.

(This is a comprehensive report on a study of all phases of refuse collection and disposal leading to development of a District plan. Only those portions relating to composting are abstracted here.)

252. The author estimates the total refuse quantity to be 3.72/lb/cap/day of which 0.67 is garbage, 2.50 is combustible rubbish, and 0.55 is non-combustible rubbish.

"Composting is the controlled decomposition of organic wastes to create humus for soils. Through composting, much of the organic waste now being buried or burned could be salvaged and used to increase the fertility of farms and gardens. Techniques for composting have been developed which remove the process from the realm of conjecture and make it simple and practical; however, the market for humus is indeterminate, and economic study does not yet suggest that composting is a practical venture for community waste disposal." The typical costs for refuse disposal show composting to be higher than any other method (i.e. $7.00/ton vs $4.00/ton for the next highest, incineration). "A $7.00 per ton composting cost presupposes mechanical composting; ridge and furrow composting in the open may be done at a cost of from $2.00 to $3.00 per ton, but may require transfer and haul to reach appropriate sites." Returns from salvage or sale of compost are not included in this estimate. "Composting costs may be reduced and a possible net profit shown if markets for compost develop." Research works on composting at University of California; Michigan State College; Tacoma, Washington; Connecticut Agr. Exp. Sta.; the 'V.A.M.' Refuse Disposal Co., Holland; are discussed.

General recommendations made for L. A. County include: District participation be limited to transfer and disposal (not collection), final disposal activities be limited to landfill site ownership and operation, that the Districts acquire sites for landfills, and that the Districts construct and operate transfer stations and vehicles as they become essential. Other recommendations were made relative to financing and amendments to the Health and Safety Code.

253. Rohde, G.: Composting of urban domestic wastes. IRGR (1) 23, May 1958 (1954/1955 - German).

(see IRGR)

254. Rossberg, H.: The new compost station in Duisburg-Huckingen. IRGR (1) 19, May 1958 (1956 - German).

(see IRGR)

255. Sauerlandt, H.: Refuse compost to reduce the shortage of humus. IRGR (2) 15-16, Oct. 1958 (1956 - German).

(see IRGR)

256. Scharff, J. W.: Composting -- The safe conversion of village refuse and nightsoil into a valuable manure. J. Malaya Branch, British Med. Assn. 4(1) 126-35, June, 1940.

256. The history of waste disposal is described as it applies to China and the Straits Settlements. Then the author discusses the history of composting from its introduction by Sir Albert Howard in India in 1931. The Indore process was modified into the Calcutta system for use in Malaya. Composting was conducted at three village centers producing about 3 tons/day and experimental vegetable and fruit crops grown with compost cultivation with excellent results. The beneficial effects of compost far outweighed those that could have been caused by nutrients in the compost. In fact, the Singapore experiments showed N contents of only 0.73% and negligible amounts of P_2O_5.

In both the "Calcutta" and "Indore" methods used at Singapore, refuse and night soil are composted in the open and turned. Temperatures average 145°F for two weeks in the Calcutta method and 150°F for three weeks in the Indore method.

Calcutta method: Refuse and night soil are layered in brick-lined trenches 12 ft x 4 ft x 2 ft deep and are mixed with a long rake. After one week the mixture is turned; after 2 more weeks it is stacked on a concrete floor for a final 2 weeks after which it is harvested.

Indore method: Refuse is stacked in heaps on levelled and drained land in piles 6 ft x 4 ft x 4 ft high. Then a trench 4 ft x 2 ft x 2 ft deep is dug in the refuse and filled with night soil and covered with refuse from the side. The heap is watered daily for a week and then turned with additional night soil added as before. A second turning and third addition of night soil is made after another week. The heap is turned again after the third and fourth weeks and left to mature for a month. The Calcutta method requires more construction and less area, while the Indore method requires longer time and considerably more labor. Both methods were sanitary.

257. Schmitz, F.: Refuse-sludge compost evaluation by an agricultural authority. IRGR (2) 16, Oct. 1958 (1956 - German).

(see IRGR)

258. Schulze, K. L.: Aerobic decomposition of organic waste material. Mich. State Univ. Interim Rept. No. 3, 51pp., Jan. 15, 1958.

This is the fourth report (see abstracts 75, 76, and 76a) on NIH Research Grant Project No. RG-4180 concerning laboratory studies on composting. In this study a rotating drum made of lucite and holding 0.75 cu ft was used in a study of oxygen consumption and CO_2 production during the composting of a synthetic garbage. Composition of the synthetic garbage was generally: potatoes, 5 lb; apples, 5 lb; ground beef, 1 lb; oranges, 4 lb; vegetables (carrots, lettuce, celery), 5 lb; coffee grounds, 0.5 lb; newspapers, 3 lb; total (wet wt.) 23.5 lb.

258. Oxygen was measured by a magnetic oxygen analyzer and CO_2 by a portable CO_2 analyzer. Other analyses, either routine or specific, included: moisture, ash, Nitrogen (total and ammoniacal), pH, temperature, and weights. Optimum moisture was found to be about 60%. In the runs, averaging 14 days long, 37.5 loss in dry weight and 40.1% loss in volatile matter occurred. Nitrogen loss averaged 10.2% but was quite variable. Sufficient oxygen was supplied by forced aeration to give at least 2 to 5% O_2 in the outlet gas. The small air flow was insufficient to evaporate moisture rapidly enough to keep pace with dry weight losses so that the moisture content continually increased during each run (average moisture content increased from 56.6% to 69.1%; average weight of moisture increased 4.3%).

Oxygen consumption varied logarithmically with temperature (arithmetic) up to the maximum of 145°F. Values were 1 to 5 mg O_2/gm volatile matter/hr or 1.4 to 7.2 cu ft of air/lb of initial volatile matter/day. Respiratory quotient ($RQ = \frac{\text{vol } CO_2}{\text{vol } O_2}$) was found to be above 1 during the initial phase of the run and below 1 during the middle and final phases, averaging 0.87. Four phases of decomposition are reported: 1) fermentation with low pH, temperatures of 90-100°F, preponderance of yeasts, and RQ above 1.0; 2) acid phase with slow rise in pH, temperatures 110-120°F, RQ below 1.0; 3) thermophilic phase with pH above 7.0, temperature above 120°F, preponderance of bacteria, and RQ below 1.0; 4) final phase with a rapid decrease in temperature.

259. Seabrook, C. S.: Composting of organic municipal wastes. Proc. 6th Pacific N. W. Ind. Wste. Conf., Univ. of Washington, 31-35, 1954.

A study was made (while the author was City Sanitary Engineer) of composting refuse and sewage sludge (filtered) as cheaply as possible at Tacoma, Washington. Sorting and grinding were considered too expensive to be practical. Separation at the source would probably result in "no end of trouble from the public". It was decided to subject all the refuse to composting and then apply simple screening to remove non-composted items. Paper presented a large problem as it apparently constituted 90% of the load. But the paper composted exactly "as cabbage leaves and other compostable material"--only requiring a longer time. Paper was considered an asset. Sludge seemed to assist in "seeding" the refuse. Later compost was used for seeding. Composting in open piles proceeded well at 60% moisture (attained by natural rainfall). But in summer, sprinkling was required to adjust moisture.

Composting was in piles 5 to 6 ft high with turning by means of a bulldozer twice a week for a period of 4 weeks. Temperatures up to 150°F were maintained inside the piles. A 4 ft x 12 ft shaker screen with three decks was rented. Top deck had 1-1/2 in openings, 2nd deck 1-in, 3rd deck 5/8-in. Virtually all the

259. material was either retained on the top screen or passed through the fine screen. Some quantity figures are given for the two experimental piles in cubic yards. Considerable gravel was included, picked up by the bulldozer. It was estimated that Tacoma wastes would amount to 35,000 cu yds of which all but 2,500 cu yds was refuse, the rest sludge. A capital outlay of $109,000 was estimated for the plant on 600,000 sq ft area. Total operating costs, including amortization, would be $94,700. At a sale value of $3.50 per cu yd of compost, income would be $130,000/year or a saving of $35,300 per year.

260. Seifert, A.: Compost, a primer for small and large gardeners, farmers and agriculturalists. IRGR (4) 17, Feb. 1959 (1957 - German).

(see IRGR)

261. Smith, C. H.: Modern hygienic refuse disposal. John Thompson Ind. Const. Ltd. Bull., 7 pp, Jan. 1958.

The three acknowledged systems of refuse disposal are discussed: (1) controlled tipping (sanitary landfill), (2) separation and incineration, and (3) pulverizing and composting. Separation includes: magnetic separation of Fe metals, screening to remove fine dust and cinders, manual picking for salvage of paper products, glass, rags, bones, and non-Fe metals. Salvage may be economical as well as helping to prepare refuse for incineration or composting.

Use of a grinder and ballistic separator (to remove inorganic fragments from the refuse) is desirable in composting. Treatment of sewage sludge or night soil with refuse serves the dual purpose of providing moisture and disposing of troublesome wastes. Proper aeration, moisture, and temperature are required and the 160°F or higher temperatures reached are lethal to fly larvae. The composter consists of (presumably six) sectionalized floors in which the material is retained for 6 days, similar to the Jersey, Channel Islands, plant. Although it is claimed the 6-day compost could be used immediately, it is preferred to store it so that the C/N value is lowered to a level "in keeping with the highest quality compost".

"Heap" composting is economic and simple, although the method is restricted. The stacking and reclaiming processes are mechanized to whatever extent is desired.

262. Smith, Cyril H.: Composting--is it worth while? (Discussion) Roy. Soc Health Jour. 78(5) 526 Sept. - Oct. 1958.

Smith of Wembley, Middlesex, in a letter to the editor, states that "of course it is worth while". He quotes from Bull. 30 of the Ministry of Agr. Manures and Fertilizers (10th ed. May 1952):

262. 'There is another aspect of the manurial problem that is scarcely less important than the provision of plant food. Crops are dependent for their satisfactory growth on good water relationship in the soil and a state of good tilth in the top soil. The soil should be in crumb structure, permeable to air and water, and in a fit condition to support the vast micro-organic population, the activity of which renders certain of the soil reserves available to the growing plant. The key to this satisfactory state of affairs is organic matter in its decomposed state in the soil. Organic matter and soil fertility are so closely connected that farmers are always on the lookout for means of supplementing the dung supply or, in special cases, of substituting some other form of organic manuring more suited to their soil conditions.'

Smith points to the need for humus and argues that the only outside sources for large supplies are garbage and sewage sludge--at present mostly improperly disposed of. He suggests the Ministry of Housing and Local Government grant loans for the building of suitable composting plants. He concurs in the need for a working party on composting, or alternatively, a Society panel.

263. Snell, John R.: Discussion of: Some engineering aspects of high-rate composting. ASCE Proc. Paper 1557, J. San. Eng. Div. 84(SA1) 9-13, Feb. 1958.

(See 106 for initial paper by Snell and prior discussion by Rogus).

In defending his recommendations in the initial paper, the author cites experience gained at pilot and full-scale plants at Michigan State University and Kobe, Japan. He also refers to the satisfactory grinding operations at the McKeesport, Pa. plant and to the windrow turner being developed by the American Dross Disposal Co. at the Omaha Stockyards. He indicates again the necessity for a full scale prototype plant and doubts that the Federal Government would finance it. Three methods of possible financing are: (1) by a municipality; (2) joint venture by a municipality and a private company in a 2:1 ratio; and (3) a cooperative venture by 5-10 municipalities. He contends composting can be operated at costs competitive with present refuse disposal methods without considering salvage or sale of compost.

264. The Soil Assn. and the Albert Howard Fnd.: Waste intc wealth. Mother Earth (Br.) Jan. 1953. (Reprint by the Soil Assn., 10 pp.).

In October 1952 the above two associations issued a joint "Memorandum on the use of wastes in agriculture and horticulture" and presented it to the Ministry of Material's Advisory Panel on Waste Materials. The memo urged utilization of sewage and "dustbin refuse". It pointed out that raw sewage or sewage sludge can be safely combined with household refuse for fermentation and production of fertilizer. An additional process, that of production

264. of methane gas, offers great possibilities for power production. The memo outlined the composting activities in Great Britian, including: (1) Dalscone and Kirkconnel plants in Dumfries Co., Scotland, producing "Eradite"; (2) Jersey, Channel Islands, plant serving St. Helier, producing 6,000 tons of compost/year; (3) the Leatherhead plant in Surrey, producing 1800 T/yr; (4) a small plant at Nuneaton, Warwickshire (200 T/yr); (5) Nantwich, Cheshire; (6) Gifford, East Lothian, Scotland; (7) Hunt's Farm, Worplesdon, Guildford, Surrey; (8) West Malvern and Colwall Sewage Works composting of sludge-sawdust; (9) Downham House Farm, Billericay, Essex plant composting straw-sludge; (10) Sharnden Manor, Mayfield, Sussex plant using straw, sawdust and sludge.

Great emphasis is placed in the next section, entitled 'Back to the Land' on the "natural methods of soil improvement and nutrition". Another section, 'Golden Garbage', describes the Pfeiffer-Stovroff composting at Oakland, California by the Compost Corp. of America, referring to 'The City with Golden Garbage' article appearing in October 31, 1952 issue of Collier's and subsequently condensed in Readers' Digest. Reference is also made to Engineering News-Record articles of June 26, 1952 and October 16, 1952, the latter indicating that the Oakland plant was shut down. Another section "Nairobi Takes to Composting" reports on composting in Nairobi, East Africe (2000 T/yr).

265. Springer, U.: The evaluation of the organic matter in humus fertilizers. IRGR (1) 16-18, May 1958 (June 1956).

(see IRGR)

266. Springer, U.: The effect of refuse and refuse-sludge composts on plants and soils. IRGR (4) 4-8, Feb. 1959 (1957 - German).

(see IRGR)

267. Springer, U.: On the utilization of municipal refuse in horticulture and agriculture. IRGR (4) 17, Feb. 1959 (1957 - German).

(see IRGR)

268. Stahlschmidt, V.: Development of the Dano (Biostabilizer) method for composting refuse and sludge. IRGR (2) 13, Oct. 1958 (1956 - German).

(see IRGR)

269. Steigerwald, E.: Refuse-sludge compost for soil improvement and fertilization. IRGR (2) 11-12, Oct. 1958 (1956 - German).

(see IRGR)

270. Steigerwald, E. and Springer, U.: Further experiments with refuse, refuse compost, and composts of refuse and sludge 1950-1952. IRGR (1) 19-22, May 1958 (1953 - German).

(see IRGR)

271. Stelmach, Zenobius: Effect of organic matter upon the soil. WHO, Zone I Environ. San. Seminar, Taipei, Taiwan, Mimeo. 31 pp. Oct. 14-Nov. 1, 1956.

(The author, Soil Science Dept., Michigan State University, reported on a literature survey covering 124 references in several languages. Parts of the author's summary are quoted here.)

"Soil physical conditions are improved by additions of organic matter. Soil aggregation, moisture holding capacity, reduction of runoff, and soil temperature are greatly improved either by the organic matter directly or indirectly by by-products of organic matter decomposition. The microbial population is greatly increased when organic matter is added to the soil. Partially decomposed organic material has more effect on the activities of microorganisms than well-decomposed material. The exchange capacity of soil increases with an increase of organic matter in the soil and leaching of plant nutrients decreases.

"The yield of crops are equal or higher when manure, green manure, or compost are added than when using commercial fertilizers alone. This may be due to increased exchange capacity of soils as well as the increased soil moisture holding capacity, improved soil aeration, and increased solubility of fixed plant nutrients. A lowering of yield is possible by addition of fresh manure, straw, or sawdust, due to tie-up of nutrients (N predominantly) by the microorganisms.

"Toxic substances may be produced as by-products during the decomposition of fresh organic matter in the soil....Combinations of organic and chemical fertilizers appear to be promising."

272. Straub, H.: The research program of der Arbeitsgemeinschaft für kommunale Abfallwirtschaft (AkA). IRGR (1) 15-16, May 1958 (June 1956 - German).

(see IRGR and AkA)

273. Straub, H.: Composting of community wastes--A report on experiences at the Baden-Baden plant. IRGR (2) 12, Oct. 1958 (1956 German).

(see IRGR)

274. Straub, H.: Evaluation of refuse-sludge composting plants in community management. IRGR (2) 14-15, Oct. 1958 (1957 - German).

(see IRGR)

275. Teensma, B.: The opening of the new compost plant at Almelo (Netherlands). IRGR (2) 3-4, Oct. 1958 (1956 - Dutch).

(see IRGR)

276. Teensma, B.: Refuse compost in poultry husbandry. IRGR (4) 8-10, Feb. 1959 (Dutch).

(see IRGR)

Teletzke, G. H. (see 230)

277. Tims, W. C.: Dewatered sludge handled by conveyor. Publ. Wks. 89 (7) 100 July 1958.

The sewage treatment plant at Coral Gables, Florida has a Komline-Sanderson Coilfilter which reduces the moisture content in the sludge to about 75%. A 4-in Hapman (tubular) conveyor with drags spaced at 12-in conveys the sludge cake 64 ft (including a lift of 26 ft) to a chute leading to a mixer of the heat drying equipment (CE-Raymond System flash dryer). The conveyor easily handles 2,450 lb/hr although it was necessary to install a packer mechanism to feed the cake properly into the conveyor. About 45 min/wk is needed to clean the conveyor which operates only 12 hrs/wk. Dried sludge is sold to the Parks Dept. for $30/ton for parkways, golf courses, and other uses. (Ed. note: There was no mention of chemical conditioning or of digestion of sludge; presumably the sludge has been previously digested.)

278. Voss, N.: Investigations of yields, effects of mineral matter and humus with refuse and refuse-sludge compost. IRGR (5) 14-16, Mar. 1959.

(see IRGR)

279. Welte, E.; Sahm, U.; and Marx, Th.: Increasing applications of aged refuse and yield of various cultivated plants. IRGR (4) 19, Feb. 1959 (1957 - German).

(see IRGR)

280. Weststrate, W.A.G.: What is good refuse compost? IRGR (1) 11-15, May 1958 (June 1956).

(see IRGR)

281. Weststrate, W.A.G.: Inauguration of the composting plant at Dantumadeel, the Netherlands. IRGR (5) 8-9, Mar. 1959.

(see IRGR)

282. Weyland, H.: Investigations on the ammonification of nitrogen in dung. Zbt. Bakt., II (110) 471-489, 1957. Water Poll. Abs., 31, 1247, June 1958.

"Investigations are described into the processes of ammonia liberation in dung, with special reference to the hydrolysis of urea in the dung. The methods of experiments and of determination of urease activity, urea, and ammonia are described. Fresh dung from the channels of cattle stalls had an average oxidation-reduction potential of -450mV at pH 9.5. No obligate anaerobic urease-forming microorganisms were isolated. The urea-decomposing microflora appeared to be exclusively composed of aerobic and facultative anaerobic organisms. With one exception (Actinomycetes) the isolated urease-formers were bacteria; spore-forming types were the most numerous. Urease-activity of different strains varied. Non-spore-formers developed in vitro a higher urease activity than spore-formers. Fresh dung had a considerably higher urease activity than pure cultures isolated from dung; the cause of this could not be determined. In aerated dung, urease activity increased greatly; in unaerated dung it remained relatively constant; this is ascribed to autolytic processes. No causative connection was found between the course of urease activity and the course of liberation of ammonia from dung. The ratio of the ammonia from urea to the total liberation of ammonia from dung is dependent on conditions of aeration. In the conditions of aeration used, the numbers of aerobic bacteria in dung decreased with time. Dung had a bactericidal effect on pure cultures. Urease activity in dung is mainly in the cells or other bearer substances but even in fresh dung there is cell-free urease. Because of the low concentration of urea in dung in comparison to the urease activity and of the high rate of hydrolysis, a rapid and complete inactivation of urease is necessary for preservation of urea. Nitrogen conservation in dung is less a microbiological than an enzymological problem if maintenance of the nitrogen compounds present in fresh dung is desired. The difficulty of enzyme inactivation lies in the high content of urease activators and urease protective substances in the dung." (WPA)

Wiley, John S. (see 230)

283. Williams, Edward R.: Refuse collection and disposal--an annotated bibliography, 1956-7. US Public Health Serv. P.H. Bibl. Series No. 4, Supp. C, 48 pp, 1958.

Short abstracts are given of 163 articles in the third supplement of this bibliography, covering the two-year period 1956-7. Eighteen articles are given under the heading "Composting and Reduction", all on composting. (see 86.)

284. Wilson, N. G.: The refuse composting plant in Edinburgh (Scotland). IRGR (5) 1-2, Mar. 1959 (English).

(see IRGR)

285. Wurfbain, H.: Experiences with composting plants using the rasping (raspel) method. IRGR (2) 13, Oct. 1958 (1956 - German).

(see IRGR)

286. Wylie, J. C.: Mechanized composting. Inst. of Public Cleansing, Pub. Wks. and Mun. Serv. Congress, 18 pp, Nov. 16, 1956.

Mechanized composting involves materials handling to speed up the composting process through segregation and reduction (grinding). Humus is stable at a C/N of 10 and, as the final decomposition of compost should occur in the soil, a value of 20 is satisfactory. Aerobic fermentation is faster and hotter than anaerobic, thus is more sanitary. The author advocates use of sewage sludge with refuse, pointing to the high contents of dust and ashes in European refuse. Methods used by VAM in Holland, the Dano process, processes used at Dumfries, Baden-Baden, Jersey, and others are briefly described. Mechanization saves labor, time and space and is better from a public health standpoint. Demand for compost at a rate of 2 pounds sterling/ton (about $5.60/ton) is almost unlimited, making the process of composting financially economic.

287. Yung, D. F. and Sun, C. J.: Report on compost studies at the Pingtung experimental plant. Taiwan Inst. of Env. Sanitation. Mimeo. 18 pp, July 15, 1958.

Pilot plant composting studies were instituted by Taiwan I.E.S. in July, 1956 with experimental bin-type units provided with forced air or turnings. Later a 25-ton/day plant of bin-type with forced air was established at Pingtung, Taiwan, China. Ten open-brick bins, each 1.44 m x 1.44 m x 0.7 m high, were constructed with an air grid and three 0.5 cu m/min blowers. Six bins were used without forced air but with turning, four units were used with forced air. Refuse is prepared by screening, sorting to remove paper, rags, bricks, metals, and non-compostable materials, ground in a hammermill and then a shredder which also flings off the larger, heavier particles. The bins are stacked with ground refuse to a height of 1 m (volume of a bin is 2.07 cu m). Moisture is adjusted to 55-65%. Various aeration rates and turning schedules were compared and some excess refuse was composted in windrows turned after the 5th and 15th days. Seven runs were completed with from 3 to 8 bins used per run. Night soil was added in 3 runs and the composting was 20 days.

Temperatures were generally 40°C on 1-day, 50°C on 2-day, and as high as 70°C from 3-day to 5-day. Ambient temperature had little effect beyond a depth of about 2 inches. Of temperatures taken at 2, 4, 8 and 12 inches depth, the latter were highest, ranging from 50 to 78°C during most of the 20-day period. Control piles, with no turning or forced aeration also showed 50°C temperatures

287. or higher for at least 15 of the 20 days. Temperatures were somewhat higher in the bins with turning (1 to 3 times) than in the control bins but the aerated bins showed delayed temperature rises and lower temperatures, particularly when aeration was continuous. The pH value showed a steady decrease from about 7.4 to 6.5 with no tendency to rise.

Decomposition of organic matter was 20 to 34% being at a greater rate for the first 5 days with forced aeration but with about the same final results as with the bins turned 3 times. Initial and final results were generally: organic matter 35-53% and 23-36%; C/N 26-34 and 16-20; total N 0.6-0.9 and 0.6-1.2; K_2O 0.8-1.0 and 0.9-1.1; P_2O_5 0.5-1.0 and 0.6-1.0. Up to 30% loss in N, 25% in P_2O_5, and 29% in K_2O by total weight resulted. Volume reductions were 15% by 5-day, 30% by 10-day, 40% by 15-day, and 45% by 20-day. Densities were increased from 0.30-0.35 ton/cu m initially to 0.50-0.55 ton/cu m finally. Greatest volume reduction and final density was obtained in the bins with forced air.

Aeration time varied from 12 to 360 hours per 20-day run at a rate of 2.9 l/min/kg of organic matter. Maximum oxygen utilization was 23% on the 4th day and was less than 10% after the 5th day. On the first day only 0.5-1.6% of the O_2 supplied was utilized.

Compost was sold for $1.10 (U.S.)/ton at the plant and had a good demand from farmers. The aeration method required only 60% of the operational cost of the turning method. Production costs were estimated at $1.52/ton by the aeration bin method. The NPK value of the compost was estimated at $2.06/ton. Because of an excessive aeration rate, best results by forced air were at an average of only 40 hours aeration during the 20 days, being intermittently applied from 5-day to 10-day only. Excessive loss of NPK was believed due to leaching and covering of the bins appeared desirable to conserve moisture and NPK.

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